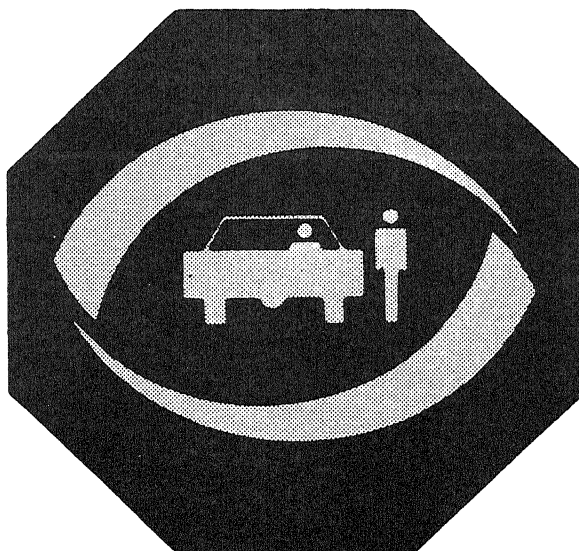






HSL No. 72-19  
October 6, 1972



**SPECIAL ANNOUNCEMENT  
ON PAGE 23**

**THIS ISSUE CONTAINS:**

HS-011 549 — HS-011 627  
HS-800 679  
HS-820 155

*U.S. Department of Transportation / National Highway Traffic Safety Administration*

# An Announcement of HIGHWAY SAFETY LITERATURE ... A Bi-Monthly Abstract Journal

Published twice-a-month by the National Highway Traffic Safety Administration,  
Research Institute, Office of Accident Investigation and Data Analysis  
Washington, D.C. 20590

## INTRODUCTION

Publications such as journal articles, proceedings, and research reports announced in *Highway Safety Literature* include some of the most recent additions to the collection of the NHTSA Scientific & Technical Information Service. Subject areas covered include all phases of highway, motor vehicle, and traffic safety, especially those encompassed by the National Traffic and Motor Vehicle Safety Act of 1966 and the Highway Safety Act of 1966.

Individual issues of *HSL* are numbered according to the year and the issue number within that year; thus, 72 designates the year and 1, 2, 3, etc. the individual issues. To aid the user in locating citations by the HS-number, the cover bears the inclusive entry number for each issue.

Entries in *HSL* are arranged according to the NHTSA Subject Category List shown in the Table of Contents. The list is a two-level arrangement consisting of five major subject fields subdivided into 59 subject groups. Documents related directly to

the National Highway Traffic Safety Administration (NHTSA) are announced in a separate section headed NHTSA DOCUMENTS and are numbered in five distinct series: NHTSA Accident Investigation Reports (HS-600 000 series), NHTSA Compliance Test Reports (HS-610 000 series), NHTSA Contractors Reports (HS-800 000 series), NHTSA Staff Speeches, Papers, etc. (HS-810 000 series), and NHTSA Imprints (HS-820 000 series). For NHTSA DOCUMENTS in series HS-600 000 and HS-610 000, individual full case reports are available for inspection at the National Highway Traffic Safety Administration. HS-800 000 series and HS-820 000 series are available for purchase from NTIS or GPO (see page ii). Although announced together in a separate section, these documents are also assigned specific subject categories for machine retrieval.

A document which contains a number of separate articles is announced as a complete volume in the subject category most applicable to it as a whole. Entries for the individual articles appear in their most specific subject category.

## SAMPLE ENTRIES

Subject Category Array \_\_\_\_\_  
NHSB Accession no .... HS-800 218 Fld. 5/21; 5/9  
Title of document ..... AN INVESTIGATION OF USED CAR  
SAFETY STANDARDS-SAFETY  
INDEX: FINAL REPORT. VOL. 6 -  
APPENDICES G-L  
Personal author(s) ..... by E. N. Wells; J. P. Fitzmaurice; C. E.  
Guilliams; S. R. Kalin; P. D. Williams  
Corporate author ..... Operations Research, Inc.  
Collation \_\_\_\_\_  
Publication date ..... 1969 150p  
Contract FH-11-6921  
Report no. ORI-TR-553-Vol-6; PB-190  
523  
Abstract ..... Appendices G-L to this study of used  
car safety standards include: indenture  
model diagrams for classes I-IV motor  
trucks; degradation, wear, and failure  
data for motor truck classes I-IV; and  
safety index tables for classes I-IV  
motor trucks.

Search terms; Wear; Trucks;  
Failures; Used cars; Inspection  
standards

## AVAILABILITY: NTIS

HS-004 497 Fld. 5/19

## AUTO THEFT—THE PROBLEM AND THE CHALLENGE

by Thomas A. Williams, Sr.

Journal citation ..... Published in *FBI Law Enforcement  
Bulletin* v37 n12 p15-7 (Dec 1968)

Gives figures on the extent of the auto  
theft problem and comments on anti-  
theft devices available now or in the  
planning stage.

Search terms: Theft; Theft pro-  
tection; Stolen cars

(Note: If the date of a report or  
Journal article is not given, the small  
letters nd will appear)

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NOTE: ( ) Numbers in parentheses following certain subject groups indicate the Highway Safety Program Standards (No. 1, and up) and/or Federal Motor Vehicle Safety Standards (No. 101 and up) which may apply to these groups.

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NOTE: Material published in Highway Safety Literature (HSL) is intended for the information and assistance of the motor vehicle and highway safety community. While brand names, equipment model names and identification, and companies may be mentioned from time to time, this data is included as an information service. Inclusion of this information in the HSL should not, under any circumstances, be construed as an endorsement or an approval of any particular product, course, or equipment by the U.S. Department of Transportation, National Highway Traffic Safety Administration.

Harry A. Feinberg  
Managing Editor

## AVAILABILITY OF DOCUMENTS AND INSTRUCTIONS FOR ORDERING

Articles and reports whose citations and abstracts appear in HSL are acquired from many sources, such as periodicals, journals, NHTSA Contractors' reports and NHTSA staff speeches, and other reports. Those reports other than NHTSA Contractors' reports and NHTSA generated reports and speeches (see introduction) are assigned a lower consecutive accession (HS-) number.

Department of Transportation personnel may borrow copies of publications announced in HSL from the NHTSA Technical Reference Division. Non-DOT Personnel, in the Washington, D.C. area, may borrow copies of publications for a 24-hour period only. Telephone (202) 426-2768. Government personnel in the Washington, D.C. area, use government ID phone 118-62768.

The names of the journals cited in HSL appear in *italic type* preceded by the words "Published in." The journal containing the article cited may be borrowed from most research and public libraries. Non-DOT personnel outside the Washington area should contact their company or agency libraries for assistance.

(Use any of the most recent *periodical directories* for location and price of publications cited in HSL)

NHTSA Contractors' reports and other reports can usually be obtained as indicated under AVAILABILITY. However, there is no certainty that copies will be available for more than a limited period after a report is issued.

The more common availability sources are identified by symbols which are explained in the next column:

NTIS: National Technical Information Service, Springfield, Va. 22151. Order by accession number: HS, AD, or PB. Prepayment is required by NTIS coupon, check or money order (made payable to NTIS). GPO coupons are not acceptable. Documents are available in paper copy (PC); in full size original or reduced facsimile, and on microfiche (MF) a 4x6" negative sheet of film (reader required).

GPO: Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Give corporate author, title, personal author, and report number. Prepayment is required by GPO coupon (NTIS coupons are not acceptable), check or money order (made payable to the Superintendent of Documents).

HRB: Highway Research Board, National Academy of Sciences, 2101 Constitution Ave., N. W., Washington, D. C. 20418.

NHTSA: National Highway Traffic Safety Administration, General Services Division, Washington, D.C. 20591 (Telephone (202) 426-0874), Give HS-No.

SAE: Society of Automotive Engineers, Dept. HSL, 2 Pennsylvania Plaza, New York, N.Y. 10001. Order by SAE report numbers. Prices given are list; discounts are available to SAE members and sometimes to libraries and U.S. Government Agencies. Prepayment is required; orders received without payment are subject to a \$1 handling charge.

## IMPORTANT NOTICE

WHEN REQUESTING a document, to be absolutely sure you receive what you order, give the accession number (HS, PB, AD number) or report number (in cases such as an SAE document), title of report, and the personal or corporate author (whichever is cited). When requesting an HS-numbered document from NTIS, add DOT/to the prefix HS-; example HS-800 000 should be ordered as DOT/HS-800 000.

# 1/0 ACCIDENTS

## 1/1 Emergency Services

HS-011 549 Fld. 1/1

### TESTING AN EMERGENCY AND REGIONAL MEDICAL HELICOPTER TRANSPORT SYSTEM (ABRIDGMENT)

by R. F. Jordan, Jr.; F. J. Wegmann; E. C. Carter

Published in *Highway Research Record* n358 p46-7 (1971)

Sponsored by Committee on Motorist Services and presented at the Highway Research Board 50th annual meeting.

The objective of this study was to plan the organization of a helicopter delivery system to serve both emergency and regional medical needs in West Virginia. Simulation techniques were used to examine alternative helicopter systems for various levels of emergency evacuations, routine interhospital patient transfers, and preventive medical care demands. Results indicate that it is possible to deploy a helicopter transport system to handle both emergency and routine medical transportation.

Search terms: Helicopter ambulances; Emergency medical services; Transportation of injured; West Virginia; Simulation models

HS-011 550 Fld. 1/1; 4/7

### MANAGEMENT SCIENCE APPROACHES TO THE DETERMINATION OF URBAN AMBULANCE REQUIREMENTS

by W. K. Hall

Published in *HIT Lab Reports* p4-8 (Jan 1972)

7ref's  
Contract FH-11-6901

Based on remarks prepared for the 1971 Systems Engineering Conference of the American Institute of Industrial Engineers, Phoenix, Ariz., 11-13 Feb 1971. Reprinted from *Socio-Economic Planning Sciences* v5 n5 p491-9 (1971).

A study was conducted in Detroit, Michigan, to determine the number and placement of ambulances necessary to provide adequate service to two selected representative urban areas. A mathematical model was developed to quantify the qualitative effects of alternative recovery system configurations, using data on the characteristics of emergency occurrence and service processes for the areas under consideration. The data analysis and the development of the analytical model are summarized, the predictions derived from the model are discussed, and the resulting recommendations presented.

Search terms: Ambulances; Mathematical models; Data analysis; Transportation of injured; Detroit; Emergency medical services; Systems analysis

## 1/2 Injuries

HS-011 551 Fld. 1/2; 5/14; 5/7; 3/2; 5/4

### STAPP CAR CRASH CONFERENCE (15TH) PROCEEDINGS, NOVEMBER 17-19, 1971, CORONADO, CALIF.

Society of Automotive Engineers, Inc.

1972 839p refs

Co-sponsored by the Univ. of Calif., Los Angeles, Wayne State Univ. and Univ. of Michigan.

Topics covered include restraint systems tests, impact tolerances and injuries, collision tests, windshield tests, anthropometry, injury data manipulation, bus accident studies, instrument panel injury mechanisms, and vehicle crashworthiness

studies. Special emphasis is given to head and neck injuries. Injury severity indexes are discussed.

Search terms: Restraint system tests; Impact tolerances; Impact tests; Windshield impact tests; Head injuries; Neck injuries; Injury severity; Bus accidents; Anthropometric dummies; Joint motion range; Accident simulation; Head restraints; Cadavers in testing; Neck motion range; Injury research; Accidents by vehicle size; Instrument panel design; Injury causes; Door design; Air bag restraint systems; Laminated glass; Restraint system effectiveness; Animal experiments

AVAILABILITY: SAE

HS-011 552 Fld. 1/2

### THE EVALUATION OF CEREBROVASCULAR AUTOREGULATION

by G. T. Tindall; K. Iwata; C. P. McGraw; B. A. Sayle

Texas Univ.

Published in HS-011 551, *Stapp Car Crash Conference (15th) Proceedings*, New York, 1972 p739-41

Report no. SAE-710878

Presented at the fifteenth Stapp Car Crash Conference, Coronado, Calif., 17-19 Nov 1971.

Autoregulation found to be present in eight of 14 severe closed head injury patients is described. It is concluded that the presence or absence of cerebral autoregulation may be of prognostic value, the absence indicating a functional loss of cerebrovascular activity. The findings also indicate that loss of autoregulation combined with an elevated intracranial pressure will probably lead to death.

Search terms: Brain injuries; Injury research; Intracranial pressure

HS-011 553 Fld. 1/2

## THE QUANTIFICATION OF INTERNAL HEAD INJURY BY MEANS OF THE PHANTOM HEAD AND THE IMPACT ASSESSMENT METHODS

by A. Slattenschek; W. Tauffkirchen; G. Benedikter

Technische Hochschule in Wien (Austria)

Published in HS-011 551, *Stapp Car Crash Conference (15th) Proceedings*, New York, 1972 p742-66

11refs  
SAE-710879

Presented at the fifteenth Stapp Car Crash Conference, Coronado, Calif., 17-19 Nov 1971.

Requirements made for a head form and the impact assessment method needed to obtain realistic test results are indicated. Particular attention is given to the possible measuring errors occurring when using unsuitable dummy bodies. The impact assessment methods devised by C. W. Gadd and the Vienna Institute of Technology are compared.

Search terms: Brain injuries; Head forms; Head impact velocities; Injury severity index; Head impact tolerances; Impact tests; Test equipment; Impact severity; Injury research

HS-011 554 Fld. 1/2

## TRANSLATIONAL VERSUS ROTATIONAL ACCELERATION — ANIMAL EXPERIMENTS WITH MEASURED INPUT

by F. J. Unterharnscheidt

Texas Univ.

Published in HS-011 551, *Stapp Car Crash Conference (15th) Proceedings*, New York, 1972 p767-70

Report no. SAE-710880

Presented at the fifteenth Stapp Car Crash Conference, Coronado, Calif., 17-19 Nov 1971.

A qualitative difference exists between the primary traumatic cortical hemorrhages produced by rotational acceleration and the so-called cortical contusions found in translational injuries. There are also different patterns of distribution for the primary traumatic lesions encountered in both types of acceleration. These lesions are arranged in a cylindrically symmetric pattern after translational acceleration, as compared to a radially symmetric pattern located close to the midline after rotational acceleration.

Search terms: Brain injuries; Acceleration injuries; Animal experiments; Animal acceleration tolerances; Injury research

HS-011 555 Fld. 1/2

## CAN SEVERITY INDEX CURVES BE DEVELOPED FOR OTHER ORGAN SYSTEMS AND TISSUES?

by J. D. States

Rochester Univ.

Published in HS-011 551, *Stapp Car Crash Conference (15th) Proceedings*, New York, 1972 p825-7

Presented at the fifteenth Stapp Car Crash Conference, Coronado, Calif., 17-19 Nov 1971.

Clinical observations show that the development of the severity indexes will depend upon analysis of the subsystem components beginning with the structural tissues. Present knowledge of human injury tolerance for trauma is insufficient to permit the development

of organ and area injury indexes (except for the head) at this time.

Search terms: Injury severity index; Human tissues; Injury tolerances

HS-011 556 Fld. 1/2

## A REVIEW OF THE SEVERITY INDEX

by J. Versace

Ford Motor Co.

Published in HS-011 551, *Stapp Car Crash Conference (15th) Proceedings*, New York, 1972 p771-96

12refs  
Report no. SAE-710881

Presented at the fifteenth Stapp Car Crash Conference, Coronado, Calif., 17-19 Nov 1971.

The SAE Severity Index is supposed to be an approximation to tolerance limit data, but there are incongruities in its derivation which render the formula unsupportable. Inconsistencies result because necessary distinctions have not been made between: the formula for a fitted approximation to the tolerance limit data, the scaling of severity as such, and the measure of the acceleration magnitude of a pulse. It is recommended that a formula which more literally follows from the tolerance limit data be adopted.

Search terms: Injury severity index; Brain injuries; Head impact tolerances; Injury research; Head acceleration tolerances; Society of Automotive Engineers

HS-011 557 Fld. 1/2

## COMPARISON OF TRANSLATIONAL AND ROTATIONAL

## HEAD MOTIONS IN EXPERIMENTAL CEREBRAL CONCUSSION

by T. A. Gennarelli; A. K. Ommaya; L. E. Thibault

National Institutes of Health

Published in HS-011 551, *Stapp Car Crash Conference (15th) Proceedings*, New York, 1972 p797-803

7refs

Contract HS-081-1-1061A

Presented at the fifteenth Stapp Car Crash Conference, Coronado, Calif., 17-19 Nov 1971.

The injurious effects of translational and rotational components of the rigid body motion response of the head to impact were compared experimentally in 11 squirrel monkeys. When the head was allowed to rotate, all animals displayed cerebral concussion. At equivalent levels of linear acceleration, no animals received concussions when head rotation was prevented and only translation allowed. Visible brain lesions were present in both groups; a higher incidence of subgaleal and subdural haematomas, subarachnoid hemorrhage, and disruption of the blood brain barrier was noted in the rotated group, whereas cerebral contusions and intracerebral haematomas, although present in both groups, were more common in the translated animals.

Search terms: Brain concussion; Head movement; Monkeys; Animal experiments; Hematoma; Impact tests; Brain injuries; Head impact tolerances; Injury research

HS-011 558 Fld. 1/2

## TOLERABLE SEVERITY INDEX IN WHOLE-HEAD, NON-MECHANICAL IMPACT

by C. W. Gadd

General Motors Res. Labs.

Published in HS-011 551, *Stapp Car Crash Conference (15th) Proceedings*, New York, 1972 p809-16

11refs

Presented at the fifteenth Stapp Car Crash Conference, Coronado, Calif., 17-19 Nov 1971.

An examination of recently available data from the standpoint of usage of a higher severity index under whole-head acceleration exposures free of mechanical impact is presented. Bio-mechanical tolerance values applicable as design goals are given. Past experiments which if analyzed in more detail will shed further light on human tolerance are summarized.

Search terms: Injury severity index; Head impact tolerances; Accident simulation; Injury research; Impact tests

HS-011 559 Fld. 1/2; 3/2

## A STRAIN ENERGY APPROACH TO THE MECHANICS OF SKULL FRACTURE

by J. W. Melvin; F. G. Evans

Michigan Univ.

Published in HS-011 551, *Stapp Car Crash Conference (15th) Proceedings*, New York, 1972 p666-85

32refs

Grant AM-03865; AM-15044

Report no. SAE-710871

Presented at the fifteenth Stapp Car Crash Conference, Coronado, Calif., 17-19 Nov 1971.

The large body of information on the phenomenology of skull fracture is summarized, and the results of numerous tests are analyzed in terms of local strain energy density. The differences and

similarities between the results of the many different studies are discussed in a qualitative manner. Conclusions are drawn on the influences of such factors as impactor size and shape, skull geometry, and soft tissue effects.

Search terms: Skull fractures; Skull; Scalp; Head impact tolerances; Bone mechanical properties; Anatomy; Human tissue mechanical properties; Injury research

HS-011 560 Fld. 1/2; 3/2

## QUANTITATIVE CORRELATION OF IMPACT AND ITS EFFECTS ON THE LIVING BODY AND ITS SURROGATES

by J. P. Stapp

National Hwy. Traf. Safety Administration

Published in HS-011 551, *Stapp Car Crash Conference (15th) Proceedings*, New York, 1972 p804-8

9refs

Presented at the fifteenth Stapp Car Crash Conference, Coronado, Calif., 17-19 Nov 1971.

Biomechanical simulation of living human response and reproducible instrumentation readings for identical test exposures must be achieved within acceptable limits of reliability. For use in compliance tests to meet safety standards, and for many research applications, a further refinement of simulation would be worth pursuing. Damage to anthropometric dummy inserts can be calibrated to the human injury spectrum and expressed as an analog of an injury severity index, in which material and structural failure correlate with severity of injury.

Search terms: Injury severity index; Anthropometric dummies; Simulation models; Injury research; Impact tests



1/2 Injuries (Cont'd)

HS-011 561 Fld. 1/2; 5/4

**MECHANISMS OF INJURIES TO UNRESTRAINED FRONT SEAT PASSENGERS AND THEIR PREVENTION BY PROGRESSIVE INSTRUMENT PANEL DESIGN**

by K. Wilfert; G. Voigt

Daimler-Benz (West Germany); Lund Univ. (Sweden)

Published in HS-011 551, *Stapp Car Crash Conference (15th) Proceedings*, New York, 1972 p437-65

9refs  
SAE-710862

Presented at the fifteenth Stapp Car Crash Conference, Coronado, Calif., 17-19 Nov 1971.

Material was gathered from autopsies of 70 passengers in head-on collisions involving passenger cars of various types, where no safety belts were used. The most important factors deciding the type of injury mechanism were the construction of the engine hood, the windshield and frame, the instrument panel, and the seat, not considering intruding objects and parts of other vehicles which may cause injuries. Corroboration of the observations was made in sled tests of head-on collisions using dummies. The results obtained are measured as forces acting in the head, the chest, and the thighs. Movement of occupants was studied when the instrument panel design was changed.

Search terms: Head on collisions; Front seat passengers; Seat caused injuries; Windshield caused injuries; Instrument panel caused injuries; Instrument panel design; Hood caused injuries; Injuries by seat occupation; Impact sleds; Autopsies; Dummies; Impact forces; Head injuries; Chest injuries; Accident simulation; Neck injuries; Leg injuries; Pelvic injuries

HS-011 562 Fld. 1/2; 5/4

**SIMULATION OF HEAD-ON COLLISION WITH UNRESTRAINED FRONT SEAT PASSENGERS AND DIFFERENT INSTRUMENT PANELS**

by G. E. Voigt; W. Lange

Lund Univ. (Sweden); Max Planck Inst. fur Arbeitsphysiologie (Germany)

Published in HS-011 551, *Stapp Car Crash Conference (15th) Proceedings*, New York, 1972 p466-88

4refs  
Report no. SAE-710863

Presented at the fifteenth Stapp Car Crash Conference, Coronado, Calif., 17-19 Nov 1971.

The accelerations above the crown of the head and at the back at the level of the middle of the chest are measured and all injuries ascertained by autopsy on unembalmed, nonbelted cadavers used in the simulation. The results give constructional ideas for the design of the instrument panel on the passenger side. To avoid injuries to the trunk and legs, the impact areas for the trunk and for the knees should be so placed as to enable the trunk to retain its almost upright position on impact. The impact area for the trunk should be as large as possible and not fold out upward.

Search terms: Head on impact tests; Front seat passengers; Accident simulation; Instrument panel caused injuries; Instrument panel design; Knee injuries; Leg injuries; Chest injuries; Spinal injuries; Impact sleds; Cadavers in testing; Neck injuries; Head injuries; Autopsies

HS-011 563 Fld. 1/2; 5/20

**BIOMECHANICS OF SNOWMOBILE SPINE INJURIES**

by V. L. Roberts; F. R. Noyes; R. P. Hubbard; J. McCabe

Published in *Journal of Biomechanics* v4 n6 p569-77 (Dec 1971)

17refs

A combined experimental and clinical study indicates that snowmobile spinal injuries are a repeatable phenomenon with seats of the current design. Redesign of snowmobiles and snowmobile suspension systems should eliminate these injuries for most practical conditions. Seven case reports of spinal injury are given. Two series of tests were made. Snowmobile seats were drop tested with an instrumented dummy in the driver's position, leading to better understanding of the interaction between rider and machine in a vertical fall. Seats were also tested to study their performance without interaction of the machine or the rider.

Search terms: Spinal injuries; Snowmobile caused injuries; Drop tests; Seat tests; Spinal impact tolerances; Seat loading; Anthropometric dummies; Seat design; Injury case reports; Biomechanics; Spinal fractures

**1/3 Investigation**

HS-011 564 Fld. 1/3

**A PILOT STUDY OF TRAFFIC CONFLICTS AT A RURAL DUAL CARRIAGEWAY INTERSECTION**

by B. R. Spicer

Road Res. Lab. (England)

1971 29p 6refs  
Report no. RRL-LR-410

The relation of traffic conflicts to injury accidents was investigated. Simple conflicts, or situations involving one or more vehicles taking evasive action, do not correlate closely with reported injury accidents, but serious conflicts, or situations involving a vehicle in a sudden rapid deceleration or lane change to avoid collision, correlate well with reported injury accidents both in loca-

tion and time of day. It is shown that more than two vehicles were present in three quarters of the conflicts studied. Three of the most common situations observed leading to multivehicle conflicts are described. Speed measurements were made, but no evidence was found which indicated that vehicles travelling faster than average were an important factor in the generation of accident situations.

Search terms: Rural intersections; Rural accidents; Intersection collisions; Accident risk forecasting; Accident location; Time of day; Traffic conflicts; Speed patterns; Accident avoidance; Accident rates; Driver emergency responses; Traffic flow; Injury statistics

#### 1/4 Locations

HS-011 565 Fld. 1/4; 3/4; 2/4

#### WRONG-WAY DRIVING. (PHASE 3). FINAL REPORT. DRIVER CHARACTERISTICS, EFFECTIVENESS OF REMEDIAL MEASURES, AND EFFECT OF RAMP TYPE

by A. Lew

California Div. of Highways

1971 36p 4refs

Data collection was by movie camera surveillance of off-ramps, incident observation by traffic enforcement officers, and accident reports. Studies of incidents were used to evaluate the effectiveness of preventive measures installed on freeways and expressways. Incident studies were also used to determine relative susceptibility of various off-ramp types to wrong-way movements. In addition, 168 wrong way drivers were interviewed. Relationships between wrong-way accidents and the factors of driver age and sobriety were also examined.

Search terms: Wrong way driving; Wrong way signs; Drinking drivers;

Driver intoxication; Warning signs; Interchanges; Accident location; Accident rates; Ramps; Pavement markings; Driver interviews; Driver characteristics; Driver age; Safety device effectiveness

#### 1/5 Statistical data

HS-011 566 Fld. 1/5

#### INDIANA TRAFFIC DEATHS 1970

by Robert K. Konkle

Indiana State Police

35p

Fatality statistics are tabulated for pedestrian deaths, time of day, area of occurrence, type of roadway, hour of occurrence, victim age classification, state wide traffic deaths per number of fatal accidents, type of accident, rural traffic deaths, urban traffic deaths, deaths by county, by month and year, by day of week, by month, and by driver residence.

Search terms: Fatalities; Accident causes; High speed caused accidents; Drinking drivers; Highway hypnosis; Defective vehicles; Pedestrian fatalities; Time of accidents; Fatalities by age; Accident types; Rural accidents; Urban accidents; Day of week; Month; Accident statistics; Accident rates; Indiana; Tailgating caused accidents; Driver fatigue caused accidents; Fatality rates; Driver residence; Highway characteristics; Right of way (traffic rules)

HS-011 567 Fld. 1/5; 4/5

#### COLLISION DATA: HSRI'S DATA GATHERING AND ANALYSIS PROGRAM

by R. E. Darby; J. O'Day

Published in *HIT Lab Reports* p1-3 (Jan 1972)

2refs

The development and applications of the accident data bank maintained by the University of Michigan's Highway Safety Research Institute are described. The program is intended to help meet the needs of highway safety researchers by enhancing the capacity to look at accidents from two approaches. The success or failure of changes in the transportation system must be determined by observation of real world traffic and accidents. Both prospective and retrospective studies are discussed.

Search terms: Information systems; Data acquisition; Data analysis; Accident statistics; Data banks; Accident reports

HS-011 568 Fld. 1/5; 5/10; 5/2

#### LIGHTING ON NON-MOTOR VEHICLES, IN PARTICULAR TRAMS

by C. Watkins

Published in *Australian Road Research* v4 n6 p3-9 (Jun 1971)

4refs

Data from accident records (1966-8) indicate that a problem of visibility exists with Melbourne streetcars at night, and that it could be alleviated by improved lighting showing the width of the tram to oncoming vehicles. Motor vehicle vs tram casualty accidents by type of collision and light condition are tabulated. The role of alcohol in these accidents is briefly discussed.

Search terms: Streetcars; Accident causes; Accident statistics; Day vs night accidents; Night visibility; Vehicle visibility; Head on collisions; Vehicle streetcar collisions; Vehicle lighting; Driver intoxication; Melbourne; Light conditions; Drinking drivers; Rear end collisions; Side impact collisions

## 2/0 HIGHWAY SAFETY

### 2/2 Communications

HS-011 569 Fld. 2/2

#### RURAL FREEWAY EMERGENCY COMMUNICATIONS FOR STRANDED MOTORISTS: FINAL PHASE REPORT

by W. J. Roth

Published in *Highway Research Record* n358 p8-16 (1971)

17refs

Sponsored by Committee on Communications and Committee on Motorist Services and presented at the Highway Research Board 50th annual meeting.

Studies were conducted to determine the level of need for any motorist aid system and the extent to which these needs were met by the system installed in Michigan. The studies show a vehicle stopping rate of 0.825 stops per mile per day in the summer and 1 stop per 2 miles per day in the winter. It is possibly coincidental, but the stopping rates increased exactly the same as the increase in winter to summer average daily traffic volumes. On the basis of present knowledge of operating motorist aid systems, a telephone communication system is recommended. This approach, together with some patrol activity and ready reference to the appropriate commercial agency, seems to provide the most desirable aid system for stranded motorists.

Search terms: Driver aid systems; Roadside telephones; Emergency road services; Emergency reporting system usage; Michigan; Summer; Winter; Traffic volume; Disabled vehicles; Trip length; Time factors; Freeways; Rural highways; Highway communication

HS-011 570 Fld. 2/2

#### USE OF AN EMERGENCY CALL-BOX SYSTEM ON AN URBAN FREEWAY

by M. E. Goolsby; W. R. McCasland

Published in *Highway Research Record* n358 p1-7 (1971)

3refs

Sponsored by Committee on Communications and presented at the Highway Research Board 50th annual meeting.

A push-button call box system was installed on an 11-mile section of I-45 in Houston. Stranded motorists may send requests for four types of aid: police, ambulance, fire, and service. During a six month period studied, 1,025 calls were placed. Rate of use of a given box was found to be a function of the distance to alternate assistance. One third of the calling motorists had left the scene before service arrived. Use and driver interview data indicated that driver understanding and acceptance of the system were not complete. More than a third of the disabled motorists were not aware of the system, while another third indicated that they did not use the system because of the costs (\$6 to \$18.50, depending on service required) involved when requesting service.

Search terms: Driver aid systems; Disabled vehicles; Emergency reporting system usage; Service needs; Emergency road services; Driver interviews; Freeways; Houston

### 2/9 Traffic Control

HS-011 571 Fld. 2/9; 4/3

#### IDENTIFICATION AND EVALUATION OF REMEDIAL AID SYSTEMS FOR PASSING MANEUVERS ON TWO-LANE

#### RURAL ROADS. VOL. 1. SUMMARY REPORT

by A. Cassel; M. S. Janoff; W. E. Amos

Franklin Inst. Res. Labs.

1970 63p 12refs  
Contract CPR-11-4193  
Report no. TR-1-201; PB-185 506

This study investigated availability of aid systems, their costs, their effects on traffic flow, accidents, and volume, and benefit cost ratios of alternative remedial aids. The results of the study showed that electronic and electromechanical remedial aids for passing maneuvers on two-lane rural roads are technologically and economically feasible, and are relatively more cost effective and less costly than most major road modifications. Such electronic systems are most beneficial on two-lane rural roads with traffic volumes ranging from 2000 to 9000 vpd. For this traffic volume range, systems would need to be installed on approximately 100,000 miles of two-lane rural road.

Search terms: Two lane roads; Rural roads; Passing aid systems; Benefit cost analysis; Overtaking; Driver aid systems; Traffic volume; Passing; Electronic devices; Parameters; State of the art studies; Traffic models; Economic analysis

AVAILABILITY: NTIS as PB-185 506

HS-011 572 Fld. 2/9

#### IDENTIFICATION AND EVALUATION OF REMEDIAL AID SYSTEMS FOR PASSING MANEUVERS ON TWO-LANE RURAL ROADS. VOL. 2. IDENTIFICATION OF PARAMETERS AFFECTING OVERTAKING AND PASSING

by A. Cassel; M. S. Janoff

Franklin Inst. Res. Labs.

1970 91p 95refs  
Contract CPR-11-4193  
Report no. TR-1-201; PB-185 507

A complete list of driver, vehicle, roadway, traffic, and environmental parameters related to overtaking and passing on two lane rural roads was developed and reduced, through an extensive literature review, to six parameters for further analysis: oncoming car speed, sight distance, driver judgment, climbing lanes and passing bays, adequate road dimensions, and signs and markings. The three general types of remedial aids to facilitate passing maneuvers on two-lane rural roads were matched to the parameters: road reconstruction and modification to design standards; traffic control devices, such as signs and markings for passing and no-passing zones; electronic or electromechanical devices providing information to drivers on traffic and roadway conditions which will help them to pass more efficiently and safely.

Search terms: Driver aid systems; Two lane roads; Rural roads; Passing aid systems; Overtaking; Traffic volume; Highway mileage; Vehicle mileage; Accident rates; Rural accidents; Accident costs; Traffic control devices; Driver performance; Driver vehicle road interfaces; Speed patterns; Warning signals; Warning signs; Pavement markings; Reviews; Passing; Parameters; Oncoming vehicles; Sight distances; Climbing lanes; Highway characteristics

**AVAILABILITY:** NTIS as PB-185 507

HS-011 573 Fld. 2/9

**IDENTIFICATION AND EVALUATION OF REMEDIAL AID SYSTEMS FOR PASSING MANEUVERS ON TWO-LANE RURAL ROADS. VOL. 3. STATE-OF-THE-ART REVIEW AND CONCEPTUALIZATION OF REMEDIAL AID SYSTEMS FOR PASSING MANEUVERS**

by M. S. Janoff; W. E. Amos; A. Cassel

Franklin Inst. Res. Labs.

1970 97p 104refs  
Contract CPR-11-4193  
Report no. TR-1-201; PB-185 508

Three different types of remedial aid systems were considered: road construction and modification to geometric design standards; traffic control devices such as signs and markings for passing and no passing zones; and electronic or electromechanical devices to provide traffic and roadway information. The last of these may be more cost effective than construction aids or signs and markings. There are no off the shelf electronic or electromechanical remedial aid systems directly applicable to the passing situation on two-lane rural roads, but such systems are well within the scope of present technology. A passing-aid system was conceptualized based on what such a system must do and within what limits. Auditory and visual criteria for driver information and warning devices are described.

Search terms: Two lane roads; Rural roads; Passing aid systems; Guidance systems; Traffic control devices; Passing zone signs; Warning systems; Automatic highways; Contrast; Hearing; Vehicle detectors; No passing zones; Electronic devices; Auditory perception; Sound intensity; Audio display systems; Visual perception; Visual acuity; Highway improvements; Highway construction; Benefit cost analysis; Driver aid systems; State of the art studies; Pavement markings; Systems analysis; Brightness

**AVAILABILITY:** NTIS as PB-185 508

HS-011 574 Fld. 2/9; 4/7

**IDENTIFICATION AND EVALUATION OF REMEDIAL AID SYSTEMS FOR PASSING MANEUVERS ON TWO-LANE RURAL ROADS. VOL. 4. TRAFFIC FLOW MODEL**

by M. S. Janoff; A. Cassel

Franklin Inst. Res. Labs.

1970 128p 14refs  
Contract CPR-11-4193  
Report no. TR-1-201; PB-185 509

A computer simulation model was developed to evaluate the traffic flow and safety benefits of alternative remedial devices which would assist drivers in solving discriminatory and judgmental problems associated with passing maneuvers. The traffic flow model is a digital computer simulation of a two-lane bi-directional isolated (no intersections) road. The main feature of the model is its simulation of the actual passing maneuver on two-lane rural roads using a predetermined passing rule which is preset before each simulation and which governs the actions of all vehicles on the road. Two basic applications of the model were considered: using existing no-passing zones for passing maneuvers by providing drivers with information describing the opposing traffic; and providing drivers with oncoming-car speed or closing rate on tangents.

Search terms: Two lane roads; Rural roads; Passing aid systems; Flow charts; Computerized simulation; Traffic models; Fortran; No passing zones; Oncoming vehicles; Computer programs; Speed patterns; Probability theory; Mathematical models; Driver aid systems; Simulation models; Traffic flow; Driver performance; Digital computers; Speed sensors; Gap acceptance; Sight distances

**AVAILABILITY:** NTIS as PB-185 509

HS-011 575 Fld. 2/9; 4/3

**IDENTIFICATION AND EVALUATION OF REMEDIAL AID SYSTEMS FOR PASSING MANEUVERS ON TWO-LANE RURAL ROADS. VOL. 5. ECONOMIC ANALYSIS OF PASSING AID SYSTEMS**

by A. Cassel; M. S. Janoff

## 2/9 Traffic Control (Cont'd.)

### HS-011 575 (Cont'd.)

Franklin Inst. Res. Labs.

1970 68p 12refs  
Contract CPR-11-4193  
Report no. TR-1-201; PB-185 510

The outputs of the traffic flow model described in Vol. 4 were converted to direct costs in order to determine the economic benefits associated with different remedial aids. These costs included running costs, speed change cycle costs, and time delay and accident costs. These costs were then compared against the direct costs associated with the no-knowledge passing rule (i.e., present conditions) to obtain economic savings. Even though electronic and electromechanical systems have benefit/cost ratios less than 1, they appear to be relatively more cost effective than other types of remediation.

Search terms: Two lane roads; Rural roads; Passing aid systems; Benefit cost analysis; Traffic simulation; Computerized simulation; Traffic models; No passing zones; Oncoming vehicles; Mathematical models; Gap acceptance; Probability theory; Speed changes; Economic analysis; Driver aid systems; Electronic devices; Passing; Vehicle operating costs; Time costs; Traffic flow; Flow charts

**AVAILABILITY:** NTIS as PB-185 510

## 3/0 HUMAN FACTORS

### HS-011 576 Fld. 3/0

#### HIGHWAY SAFETY PROGRAM MANAGEMENT—A SYLLABUS

by J. E. Carnahan

Highway Users Federation for Safety and Mobility

1970 173p 65refs

Funded by the Automotive Safety Foundation.

The syllabus was developed to assist highway safety and college administrators in training highway safety management personnel. The outline covers the highway transportation system, nature and characteristics of management systems, elements of the highway safety program, highway safety management, and program improvement.

Search terms: Highway safety organization management; Highway safety programs; Manpower utilization; Decision making; Management; Program evaluation; Leadership

### 3/1 Alcohol

#### HS-011 577 Fld. 3/1; 4/1

#### A LEGISLATIVE APPROACH TO ALCOHOL AND HIGHWAY SAFETY

by M. H. Wagner

Published in *State Government* v45 n1 p51-4 (Winter 1972)

The enactment of more effective alcohol laws in the states during the last few years is discussed. Areas described are: implied consent laws, chemical test provisions, chemical testing procedures and certifications, and quantitative tests for alcohol in fatal accidents. Other innovative, relatively harsh, and certainly controversial laws are being suggested for enactment in the areas of arrest law, mandatory jail terms and pre-sentence investigations, civil commitment for treatment of alcoholism, revocation of registration certificates and plates, special certificates and plates, impounding or confiscation of vehicles, restricted or limited driver licenses, rehabilitation programs, and insurance penalties.

Search terms: Alcohol usage deterrents; Alcohol laws; State laws; Implied consent laws; Alcohol chemi-

cal tests; Blood alcohol levels; Fatalities; Alcoholism; Drinking drivers; Driver intoxication; Driver rehabilitation; Arrests; Penalties; Driver prosecution; Driver license restrictions; Insurance costs; Vehicle registration; License plates; Impoundment

### 3/2 Anthropomorphic Data

#### HS-011 578 Fld. 3/2

#### THE EFFECT ON DATA REPRODUCIBILITY OF DUMMY MODIFICATION

by J. F. Sprouffske; W. H. Muzzy; E. M. Trout; T. D. Clarke; C. D. Gragg

Aerospace Medical Res. Lab. (6570th)

Published in HS-011 551, *Stapp Car Crash Conference (15th) Proceedings*, New York, 1972 p1-12

6refs  
Report no. SAE-710847

Presented at the fifteenth Stapp Car Crash Conference, Coronado, Calif., 17-19 Nov 1971.

Studies were made to determine if the variability of dummy performance could be reduced by refinishing the joints and bearing surfaces of the dummy, and to establish a technique for preparing dummies for dynamic tests and measurements to be made for evaluating dummy performance. In each of three test phases the lap belt, seat pan down, and seat pan forward loads were obtained. The results indicate that the standard errors about the regression lines of force versus deceleration were significantly decreased compared to previous studies. The seat pan forward force remained relatively constant if the dummy's joints were adjusted between each test.

Search terms: Anthropometric dummies; Sitting (body position); Joints (Anatomy); Deceleration tests; Seat belt loading; Seat loading measurement

HS-011 579 Fld. 3/2

**JOINT RANGE OF MOTION AND MOBILITY OF THE HUMAN TORSO**

by R. G. Snyder; D. B. Chaffin; R. K. Schutz

Michigan Univ.

Published in HS-011 551, *Stapp Car Crash Conference (15th) Proceedings*, New York, 1972 p13-41

35refs

Contract F-33615-70-0-1777

Report no. SAE-710848

Presented at the fifteenth Stapp Car Crash Conference, Coronado, Calif., 17-19 Nov 1971.

A multidisciplinary investigation was made to develop a quantitative description of the mobility of the human torso. Positional and dimensional data were obtained for 72 anthropometric dimensions on 28 living male subjects statistically representative of the 1967 USAF anthropometric survey. Centers of joint rotation (link and positions) for the torso and limbs, lengths of functional torso links, and link excursions were correlated with linear body dimensions and landmarks obtained in traditional anthropometry. Three simultaneous regression equations were used to develop predictive models for torso positions referenced to a sitting or standing position or task. Major results of the study were prediction equations and graphs describing how the base of the spine reference point moves in relation to defined seated and standing reference points for given reaches, and the development of techniques by which the lengths and excursions of torso and limb links may be estimated and located.

Search terms: Anthropometry; Joints (anatomy); Dissection; Radiography; Photogrammetry; Joint motion range; Standing (body position); Sitting (body position); Multidisciplinary

teams; Human body segment parameters

HS-011 580 Fld. 3/2

**STRENGTH AND RESPONSE OF THE HUMAN NECK**

by H. J. Mertz; L. M. Patrick

General Motors Res. Labs.; Wayne State Univ.

Published in HS-011 551, *Stapp Car Crash Conference (15th) Proceedings*, New York, 1972 p207-55

10refs

Report no. SAE-710855

Presented at the fifteenth Stapp Car Crash Conference, Coronado, Calif., 17-19 Nov 1971.

Analysis of the data from volunteer and cadaver experiments indicates that equivalent moment at the occipital condyles is the critical injury parameter in extension and in flexion. Static voluntary levels of 17.5 ft lb in extension and 26 ft lb in flexion were attained. A maximum dynamic value of 35 ft lb in extension was reached without injury. Noninjurious neck shear and axial forces of 190 lb and 250 lb are recommended based on the static strength data obtained on the volunteers. Neck response envelopes for performance of mechanical necks are given for the extension and flexion modes of the neck.

Search terms: Neck injuries; Neck motion range; Flexion; Static loads; Dynamic loads; Test volunteers; Cadavers in testing; Deceleration tests; Head motion range; Human deceleration tolerances; Injury research

HS-011 581 Fld. 3/2

**A STUDY OF RESPONSES AND TOLERANCES OF THE NECK**

by C. W. Gadd; C. C. Culver; A. M. Nahum

General Motors Res. Labs.; University Hosp., San Diego, Calif.

Published in HS-011 551, *Stapp Car Crash Conference (15th) Proceedings*, New York, 1972 p256-68

4refs

Report no. SAE-710856

Presented at the fifteenth Stapp Car Crash Conference, Coronado, Calif., 17-19 Nov 1971.

Resistance of the head-neck system to hyperextension and lateral angulation was found to follow concave-upward curves which reached a level of 200 in /lb in the range of 70-90° in hyperextension and 60-70° laterally. Evidence of minor injury to the neck appeared at approximately 80° in hyperextension and 60° laterally in the cadavers tested. Supplementary tests conducted dynamically and involving load rise times in the range of 20-30 ms showed little overall differences in angulation. Tolerance of the laryngeal cartilages to localized impact over 1 sq in was found to be in the range of 90-100 lb.

Search terms: Neck motion range; Dynamic loads; Static loads; Impact tests; Cadavers in testing; Cervical spine motion measurement; Throat impact tolerances; Injury research

HS-011 582 Fld. 3/2; 1/2

**IMPACT TOLERANCE AND RESPONSE OF THE HUMAN THORAX**

by C. K. Kroell; D. C. Schneider; A. M. Nahum

General Motors Res. Labs.; University Hosp., San Diego, Calif.

Published in HS-011 551, *Stapp Car Crash Conference (15th) Proceedings*, New York, 1972 p84-134

**3/2 Anthropomorphic Data (Cont'd.)****HS-011 582 (Cont'd.)**

4refs

Report no. SAE-710851

Presented at the fifteenth Stapp Car Crash Conference, Coronado, Calif., 17-19 Nov 1971.

The objective of the study is to provide improved quantification of injury tolerance and thoracic mechanical response for blunt sternal impact to the human cadaver. Fourteen unembalmed specimens of both sexes (ranging in age from 19-81 years, in weight from 117-180 lb, and in stature from 5 ft 1-1/2 in to 6 ft) have been exposed to midsternal, blunt impacts using a horizontal, elastic-cord propelled striker mass. Impact velocities ranged from 14-32 mph. Striker weight varied from 3.6-52 lb, the smaller masses associated with the higher velocities. In twelve cases the thoracic aorta was liquid pressurized at impact; and in seven cases, intra-aortic and intraventricular pressure-time histories were recorded during the impact event. Thoracic autopsies with cardiovascular dissections were performed in all cases and thorough abdominal explorations were performed in nine.

Search terms: Chest impact tolerances; Chest injuries; Impact tests; Impact velocity; Cadavers in testing; Autopsies; Impact caused skeletal damage; Aortic injuries; Test equipment; Internal injuries; Impact forces; Injury research

**HS-011 583 Fld. 3/2; 1/2****THORACIC TOLERANCE TO WHOLE-BODY DECELERATION**

by H. J. Mertz; C. W. Gadd

General Motors Res. Labs.

Published in HS-011 551, *Stapp Car Crash Conference (15th) Proceedings*, New York, 1972 p135-57

29refs

Report no. SAE-710852

Presented at the fifteenth Stapp Car Crash Conference, Coronado, Calif., 17-19 Nov 1971.

Impact velocities and corresponding stopping distances for the thorax and the head were calculated from high-speed movies of sixteen dives from heights between 27-57 ft. For a 57-ft dive, the impact velocity of the thorax was 41 mph with a corresponding stopping distance of 34.6 in. The peak resultant deceleration of the thorax was 49.2 g with a pulse duration of 100 ms. The maximum rate of change of the deceleration of the thorax was 5900 g/s. No discomfort was experienced as a result of this impact. The maximum forehead deceleration occurred during a 47.0-ft drop and exceeded 56 g with a Gadd Severity Index greater than 465.

Search terms: Chest impact tolerances; Deceleration tolerances; Impact velocity; Head impact tolerances; Impact tests; Impact severity

**HS-011 584 Fld. 3/2; 4/7****A COMPARISON BETWEEN HUMAN KINEMATICS AND THE PREDICTIONS OF MATHEMATICAL CRASH VICTIM SIMULATORS**

by D. H. Robbins; R. G. Snyder; J. H. McElhaney; V. L. Roberts

Michigan Univ. Hwy. Safety Res. Inst.

Published in HS-011 551, *Stapp Car Crash Conference (15th) Proceedings*, New York, 1972 p42-67

8refs

Contract FH-11-6962

Report no. SAE-710849

Presented at the fifteenth Stapp Car Crash Conference, Coronado, Calif., 17-19 Nov 1971.

A computer simulation model has been prepared to determine the differences

observed between the motions of a living human impact sled test subject and a dummy test subject. A series of measurements were taken on human test subjects, including classical and non-classical anthropometric measurements, range of motion measurements for the joints, and maximum foot force measurements. Mathematical expressions have been used to predict body segment weight, centers of gravity and moments of inertia using the results of the various body measurements. A computer simulation of an impact sled test involving a human volunteer was made. Results were sufficiently accurate to show promise of analytical tools to compare results of dummy tests with human tests.

Search terms: Mathematical models; Joint motion range; Anthropometry; Shoulder motion range; Neck motion range; Knee flexion; Elbow flexion; Hip flexion; Human deceleration tolerances; Impact sleds; Impact tests; Human body kinematics; Accident simulation; Computerized simulation; Human body segment parameters; Human body center of gravity; Spinal flexion; Muscular forces; Human body mass moment of inertia; Simulation models

**HS-011 585 Fld. 3/2; 1/2****COMPARISON OF HEAD ACCELERATION INJURY INDICES IN CADAVER SKULL FRACTURE**

by V. R. Hodgson; L. M. Thomas

Wayne State Univ.

Published in HS-011 551, *Stapp Car Crash Conference (15th) Proceedings*, New York, 1972 p190-206

5refs

Contract FH-11-7609

Report no. SAE-710854

Presented at the fifteenth Stapp Car Crash Conference, Coronado, Calif., 17-19 Nov 1971.

Skull fracture was produced in forty cadavers which were dropped with their heads striking rigid flat, hemispherical, and cylindrically shaped surfaces on the front, side, and rear. Severity index and effective displacement index are compared at fracture level for all frontal impacts and the frontal flat plate results are compared to the Wayne State Cerebral Concussion Tolerance Curve. Indices calculated for Alderson 50th percentile dummy frontal head impacts onto a rigid flat plate are found to be higher than those for cadaver skull fracture impacts in the same drop height range.

Search terms: Skull fractures; Head impact tolerances; Cadavers in testing; Impact caused injuries; Injury severity index; Drop tests; Injury research

HS-011 586 Fld. 3/2; 5/14

#### HUMAN HEAD LINEAR AND ANGULAR ACCELERATIONS DURING IMPACT

by T. D. Clarke; C. D. Gragg; J. F. Sprouffske; E. M. Trout; R. M. Zimmerman; W. H. Muzzy

Aerospace Medical Res. Lab. (6570th); New Mexico State Univ.; Naval Aerospace Medical Res. Lab.

Published in HS-011 551, *Stapp Car Crash Conference (15th) Proceedings*, New York, 1972 p269-86

7refs  
Report no. SAE-710857

Presented at the fifteenth Stapp Car Crash Conference, Coronado, Calif., 17-19 Nov 1971.

Head linear and angular accelerations of 14 humans were investigated during exposure to abrupt linear deceleration ranging from 7.7 to 10.3 g. Three different restraints, lab belt only, Air Force shoulder harness-lap belt, and air bag plus lap belt were used. The results indicated that peak head angular and

linear resultant accelerations were elevated with the air bag in contrast to the Air Force shoulder harness or lap belt only restraints. However, the peak angular and linear accelerations may have less traumatic consequences than the degree of head-neck hyperextension.

Search terms: Angular acceleration; Head acceleration tolerances; Deceleration tests; Human deceleration tolerances; Neck; Air bag restraint systems; Seat belts; Shoulder harnesses; Headache; Test volunteers; Restraint system tests; Restraint system effectiveness

HS-011 587 Fld. 3/2; 5/20

#### HUMAN FACTORS METHODOLOGY IN THE DESIGN OF THE DRIVER'S WORKSPACE IN TRUCKS

by P. Kyropoulos

General Motors Corp.

1972 21p 36refs  
Report no. SP-367

Presented as the 18th L. Ray Buckendale Lecture.

The methodology of human factors as applied to the design of truck cabs is discussed, emphasizing the need for constructing mockups and for experiments using typical users as test subjects. The basic elements of anthropometrics are reviewed. Seeing is treated as the first step in the decision making process. It is the most important channel of communication between the driver, the vehicle, and the surrounding road and traffic. Control location and identification is a problem in communication between driver and vehicle. Control forces, seating, and environmental requirements of comfort and alertness are reviewed. The roles of simulation and simulators are essential in human factors design. The role of mathematical models is examined.

Search terms: Truck cab interiors; Human factors engineering; Ergosphere; Anthropometry; Driver vehicle road interfaces; Decision making; Control location; Driving task analysis; Mathematical models; Scale models; Test volunteers; Visual behavior; Seat design; Driving simulation; Laboratory tests

AVAILABILITY: SAE

#### 3/4 Driver Behavior

HS-011 588 Fld. 3/4

#### JUDGMENT OF VEHICLE SPEEDS AND TRAFFIC PATTERNS: PHASE 4. INTERIM REPORT

by H. W. Case; S. F. Hulbert

California Univ. ITTE

1971 35p 45refs  
Report no. RTA-13945-1 3642

Sponsored by California Div. of Highways and Bureau of Public Roads.

Drivers' speed estimations taken in the UCLA Driving Simulation Laboratory indicated large under-accelerations (overestimations) from engine speed alone and no correlation between these and other estimations; medium accuracy and correlation with other estimations from visual cues alone; a high level of accuracy in instructed specific speeds and free driving estimations when driving normally; a positive correlation between specific and free speed estimations; and little accuracy or correlation for proportional estimations.

Search terms: Speed studies; Driving simulation; Young adult drivers; Driver behavior research; Velocity perception; Motion perception; Distance perception; Engine speeds; Visual behavior; Driving task analysis; Acceleration; Speed changes; Correlation analysis; Deceleration



**3/8 Environment Effects****HS-011 589** Fld. 3/8**AEROSOL FORMATION IN  
PHOTOCHEMICAL SMOG. I.  
EFFECT OF STIRRING**

by William E. Wilson, Jr.; E. L. Merryman; Arthur Levy; Harold R. Taliaferro

Published in *Journal of the Air Pollution Control Association* v21 n3 p128-32 (Mar 1971)

11refs

Supported by the American Petroleum Inst.

Experiments conducted at Battelle's Columbus Laboratories in a 200-liter and a 610-cu ft smog chamber show that stirring can decrease aerosol formation. Sufficiently rapid stirring can completely prevent observation of aerosol formation by light scattering. The differences in sensitivity to stirring between olefins and aromatics, and between systems which do or do not contain sulfur dioxide, account for many of the discrepancies in the literature on aerosol formation.

Search terms: Smog; Nitric oxide; Sulfur dioxide; Smog chambers; Aerosols; Olefins; Aromatic compounds

**HS-011 590** Fld. 3/8; 3/4**EFFECTS ON EXPERIMENTAL  
ANIMALS OF LONG-TERM IN-  
HALATION EXPOSURE TO  
CARBON MONOXIDE**

by R. A. Jones; J. A. Strickland; J. A. Stunkard; J. Siegel

Published in *Toxicology and Applied Pharmacology* v19 n1 p46-53 (May 1971)

17refs

Rats, guinea pigs, monkeys, and dogs were exposed continuously for 90 days to 51, 96, and 200 ppm carbon

monoxide. Animals were also exposed repeatedly eight hours/day, five days/week for 6 consecutive weeks to 106 ppm. No adverse toxic signs were noted during these studies. After the continuous exposures to 96 and 200 ppm, the mean hemoglobin and hematocrit values of all four species were elevated when compared to preexposure values. The carboxyhemoglobin (COHb) values at equilibrium were determined for the four species exposed continuously for 48 hours at the three concentrations. These COHb values correlated well with the affinity constants for the different species, and agreed closely with the theoretical calculated values.

Search terms: Carbon monoxide; Carboxyhemoglobin; Animal experiments; Health hazards research; Blood carbon monoxide levels; Dogs; Guinea pigs; Monkeys; Rats

**3/11 Pedestrians****HS-011 591** Fld. 3/11; 2/4**DESIGNING FOR PEDES-  
TRIANS: A LEVEL-OF-SERVICE  
CONCEPT**

by J. J. Fruin

Published in *Highway Research Record* n355 p1-15 (1971)

9refs

Sponsored by Committee on Pedestrians and presented at Highway Research Board 50th annual meeting.

Pedestrian facilities should be designed on the basis of qualitative as well as quantitative factors. Present procedures involve the use of maximum capacity ratings for design. The capacity of a pedestrian traffic stream invariably occurs at the heaviest concentrations combined with restricted walking speeds. This condition is not representative of a comfortable human environment. Time-lapse photography studies make it possible to establish the relationship

between volume, speed, and human convenience at different pedestrian concentrations. The studies form the basis for six levels of service for the design of walkways and stairways. These levels of service provide a qualitative method of designing new or evaluating existing pedestrian environments.

Search terms: Pedestrian density; Walking speed; Sidewalks; Traffic capacity; Pedestrian safety; Comfort; Traffic volume; Design standards; Mathematical models; Traffic conflicts; Stairways; Time lapse photography

**HS-011 592** Fld. 3/11; 2/9**INVESTIGATION OF THE  
CAPACITY OF THE WHITE  
HOUSE SIDEWALK FOR ORDER-  
LY DEMONSTRATIONS**

by V. H. Surti; T. J. Burke

Published in *Highway Research Record* n355 p16-25 (1971)

13refs

Sponsored by Committee on Pedestrians and presented at Highway Research Board 50th annual meeting.

The objective of this study was to determine how many demonstrators could use the White House sidewalk without impeding the normal flow of pedestrian traffic. Estimates were made of the number of pedestrians that would use this sidewalk during peak periods throughout the year and of the amount of space which could accommodate that demand. The remaining sidewalk space was then investigated to estimate the maximum number of demonstrators it could accommodate for three types of demonstrations: continuous walking by a group, standing still by a group, and walking by without returning by a large group.

Search terms: Pedestrian density; Traffic flow; Traffic capacity; District

of Columbia; Traffic impedances;  
Walking speed

**HS-011 593 Fld. 3/11; 2/9**

### PEDESTRIAN WAY CONCEPTS AND CASE STUDIES

by H. S. Levinson

Published in *Highway Research Record*  
n355 p69-89 (1971)

3refs

Sponsored by Committee on Pedestrians and Committee on Parking and Terminals and presented at Highway Research Board 50th annual meeting.

Pedestrian circulation concepts for the southwest employment area in Washington, D.C. and for downtown Seattle, Washington, are described. These case studies indicate the importance of achieving pedestrian movement continuity, separating pedestrian and vehicle improvements, and preserving pedestrian movement corridors.

Search terms: Pedestrian dynamics; Pedestrian safety; Pedestrian density; Pedestrian crossings; Traffic conflicts; Traffic volume; Peak hour traffic; Pedestrian bridges; Pedestrian control; District of Columbia; Seattle; Transportation planning

**HS-011 594 Fld. 3/11; 2/9**

### PEDESTRIAN EFFECT ON AT- GRADE INTERSECTION VEHICULAR FLOW

by J. R. Nesselrodt; J. C. Yu

Published in *Highway Research Record*  
n355 p26-36 (1971)

19refs

Sponsored by Committee on Pedestrians and presented at Highway Research Board 50th annual meeting.

Data were collected and analyzed to determine if a statistical relationship existed between the selected variables and the vehicle-seconds of delay being caused by pedestrian-vehicle frictions as a result of both vehicular and pedestrian movements. Multiple regression analysis of the data produced three regression models which should give accurate estimates of the vehicle seconds of delay. The first model included the data for six intersections, three with all one-way streets intersecting and three with a one-way street and a two-way street connecting. The second model was applied to three intersections with one-way streets intersecting. The third model was derived from the data on three intersections with two one-way street legs and two two-way street legs. A definite statistical relationship was found to explain the pedestrian effects on vehicle delay at typical urban intersections.

Search terms: Traffic conflicts; Regression analysis; Traffic flow; Pedestrian dynamics; Waiting time; One way streets; Urban intersections; Variables; Mathematical models; Simulation models; Pedestrian vehicle interface

**HS-011 595 Fld. 3/11; 2/9; 4/8**

### PEDESTRIAN CIRCULATION SYSTEMS IN CANADA

by V. S. Pendakur

Published in *Highway Research Record*  
n355 p54-68 (1971)

33refs

Sponsored by Committee on Pedestrians and Committee on Parking and Terminals and presented at Highway Research Board 50th annual meeting.

Conceptual aspects of planning and documenting pedestrian circulation systems in Montreal, Toronto, and Calgary are described. System characteristics, configurations, concepts, and

linkages are discussed. Canadian experience appears to indicate that the theoretical concepts of pedestrian-vehicle segregation advocated for many years are being incorporated as planning principles. No attempt has yet been made to apply methods of benefit cost analysis or determine optimum user-cost criteria. Although the surface road and sidewalk systems are built at public expense, it is assumed that private developers must pay for all or part of the segregated pedestrian systems. In the three cities discussed, adequate linkages with the public transport system are being included. Although the general tendency seems to be to design underground pedestrian systems, above ground systems are also being tried.

Search terms: Transportation planning; Pedestrian safety; Pedestrian dynamics; Pedestrian control; Montreal; Toronto; Calgary; Traffic conflicts; Public transportation; Financing; Benefit cost analysis; Economic factors

**HS-011 596 Fld. 3/11; 4/8**

### PEDESTRIAN TRAVEL DEMAND

by B. Pushkarev; J. F. Zupan

Published in *Highway Research Record*  
n355 p37-53 (1971)

4refs

Sponsored by Committee on Transportation Forecasting and presented at Highway Research Board 50th annual meeting.

Transportation planning studies have not accounted adequately for pedestrian travel demand in central business districts. Pedestrian facilities are seldom dimensioned in proportion to the trip generation of the buildings they serve, resulting in pedestrian congestion. This study, focused on midtown Manhattan, relates pedestrian density to walkway space and building floor space at two points in time. Available walkway space

**3/11 Pedestrians (Cont'd.)****HS-011 596 (Cont'd.)**

and building floor space in retail, restaurant, and office use are found to affect the presence of pedestrians. Estimating equations are presented and evaluated. Daily cyclical variation and directional distribution of pedestrian travel at buildings with different uses and at selected street locations are given. Relationships to daily trip generation rates and the relative magnitude of design period flow are suggested. Trip length characteristics are shown for the walking portion of various trips at the central business district end and are analyzed by purpose and mode.

Search terms: Transportation planning; Central business districts; New York (City); Pedestrian density; Pedestrian traffic models; Traffic generation; Trip length; Pedestrian dynamics; Equations; Statistical analysis; Peak hour traffic; Sidewalks; Walking speed

concluded that a distance of 90 feet appears to be minimal for a driver traveling at 25 mph to stop in time to avoid a collision within an intersection. From the point at which the driver must have a clear view of oncoming traffic, a sight triangle can be determined which will indicate how much of the street right of way and corner lot are included in his line of vision. Building setbacks are also considered.

Search terms: Intersections; Stopping distance; Sight distances; Visibility; Driver reaction time; Building setbacks; Speed patterns; Field of view; Deceleration; Mathematical models

**AVAILABILITY:** NTIS as PB-198 387

**4/0 OTHER SAFETY-RELATED AREAS****4/3 Cost Effectiveness**

**HS-011 598** Fld. 4/3; 4/5; 2/2

**EVALUATION OF FREEWAY EMERGENCY SERVICE SYSTEMS USING A SIMULATION MODEL**

by M. Sakashita; C. K. Lu; A. D. May

Published in *Highway Research Record* n358 p26-45 (1971)

13refs

Sponsored by Committee on Motorist Services and presented at the Highway Research Board 50th annual meeting.

The chronological sequence of events performed by the major components (police, mechanical, and communication service) of an emergency service system in responding to freeway incidents has been represented in a simulation model. Thirty selected candidate systems were simulated on the San Francisco-Oakland Bay Bridge by using a set of historical incident data. The performance of alternative systems was evaluated separately

by a cost effectiveness analysis and a total system cost procedure. The total delay to all motorists affected by the incident was selected as the representative effectiveness measure for the evaluation. The most promising of the 30 systems tested was the one with call box units spaced at ¼ mile intervals, two stationary police units, and three stationary mechanical service units. The model has the potential to be extended to include other system components such as medical service.

Search terms: Disabled vehicles; Service needs; Emergency road services; Emergency reporting systems; San Francisco; Benefit cost analysis; Simulation models; Freeways; Time costs; Computerized simulation; Flow charts; Systems analysis; Time factors; Police response time

**4/5 Information Technology**

**HS-011 599** Fld. 4/5; 1/2

**FIELD APPLICATION AND RESEARCH DEVELOPMENT OF THE ABBREVIATED INJURY SCALE**

by J. D. States; H. A. Fenner, Jr.; E. E. Flamboe; W. D. Nelson; L. N. Hames

Rochester Univ; American Assoc. For Automotive Medicine; National Hwy. Traf. Safety Administration; General Motors Proving Ground; American Medical Assoc.

Published in HS-011 551, *Stapp Car Crash Conference (15th) Proceedings*, New York, 1972 p710-38

5refs

Report no. SAE-710873

Presented at the fifteenth Stapp Car Crash Conference, Coronado, Calif., 17-19 Nov 1971.

The experience and problems involved in the use of the Abbreviated Injury Scale

**3/12 Vision**

**HS-011 597** Fld. 3/12; 2/4

**VISION CLEARANCE AT INTERSECTIONS**

Oregon Univ.

1970 23p  
Report no. Planning-Bull-3; PB-198 387

Supported by a grant from the Department of Housing and Urban Development.

A method of determining the size of the area that must be kept free of obstructions in the absence of traffic control devices on low volume streets is discussed. Even where control devices are installed, the degree of vision clearance described may be desirable. The factors which must be considered are speed of the traffic, deceleration rate of vehicles, and reaction time for drivers. It was

(AIS) are reviewed. An extended and revised AIS has been developed. Validation studies revealed better than 80% accuracy by multiple users. The Comprehensive Research Injury Scale (CRIS) has been completed for all major medical specialties. The CRIS separates the various criteria (energy dissipation, threat to life, permanent impairment, treatment period, incidence) used with variable quantities and frequencies in the AIS.

Search terms: Injury severity index; Injury classification; Multidisciplinary teams; Validation; Injury research

**HS-011 600** Fld. 4/5; 1/5

#### **A STATISTICAL SURVEY AND A METHODOLOGY USED TO DEAL WITH THE OBSERVATIONS COLLECTED FROM 6000 ROAD CASUALTIES**

by P. Bourret; N. Alaouie; M. C. Rambach; M. Margaine; O. Coppet

Salon-de-Provence Hosp. (France); Organisme National de Securite Routiere (France)

Published in HS-011 551, *Stapp Car Crash Conference (15th) Proceedings*, New York, 1972 p287-300

Report no. SAE-710859

Presented at the fifteenth Stapp Car Crash Conference, Coronado, Calif., 17-19 Nov 1971.

A data base of the circumstances of 800 accidents, the injuries observed, their treatment, evolution, and final results with their sociological and economical consequences has been established. The data can be used for various studies such as injury frequency, length of hospital stay, mortality relationship with road type or age, and accident location.

Search terms: Data processing; Accident statistics; Fatality rates; Injury rates; Accident types; France; Data

analysis; Injuries by body area; Fatalities by age; Recovery time

#### **4/7 Mathematical Sciences**

**HS-011 601** Fld. 4/7; 1/2

#### **INTERNAL HEAD INJURY ASSESSMENT**

by W. R. S. Fan

Ford Motor Co.

Published in HS-011 551, *Stapp Car Crash Conference, (15th) Proceedings*, New York, 1972 p645-65

13refs  
SAE-710870

Presented at the fifteenth Stapp Car Crash Conference, Coronado, Calif., 17-19 Nov 1971.

A revised severity index calculation was derived according to the weighted-impulse concept on the basis of the Wayne State Tolerance (WST) curve. The calculated severity indices for the data of the WST curve are approximately 305. A revised brain model was obtained on the basis of the Vienna Institute of Technology brain model, with the addition of the available information regarding the dynamic properties of the human brain-skull system. The equivalent viscous damping of the brain model is approximately 40% of critical viscous damping. The maximum deviation between the revised models and the WST curve is within 5%.

Search terms: Brain; Brain injuries; Head impact tolerances; Injury severity; Skull fractures; Mathematical models; Brain concussion; Injury research

**HS-011 602** Fld. 4/7; 1/2

#### **THE EFFECTIVE DISPLACEMENT INDEX — AN ANALYSIS**

#### **TECHNIQUE FOR CRASH IMPACTS ON ANTHROPOMETRIC DUMMIES**

by J. Brinn; S. E. Staffeld

Ford Motor Co.

Published in HS-011 551, *Stapp Car Crash Conference (15th) Proceedings*, New York, 1972 p817-24

12refs

Presented at the fifteenth Stapp Car Crash Conference, Coronado, Calif., 17-19 Nov 1971.

Advantages of the Effective Displacement Index over other evaluation techniques are: it is unambiguous; it is not inherently sensitive to small changes in instrumentation or resonances of dummy components; and its associated electronics for on-line real time readout is inexpensive, readily available, and foolproof.

Search terms: Anthropometric dummies; Injury severity index; Head impact tolerances; Chest impact tolerances; Mathematical models; Impact tests; Injury research

**HS-011 603** Fld. 4/7; 5/14

#### **MICHIGAN INJURY CRITERIA HYPOTHESIS AND RESTRAINT SYSTEM EFFECTIVENESS INDEX**

by D. H. Robbins; V. L. Roberts

Michigan Univ. Hwy. Safety Res. Inst.

Published in HS-011 551, *Stapp Car Crash Conference (15th) Proceedings*, New York, 1972 p686-709

13refs  
Contract FH-11-6962  
Report no. SAE-710872

Presented at the fifteenth Stapp Car Crash Conference, Coronado, Calif., 17-19 Nov 1971.

**4/7 Mathematical Sciences (Cont'd.)****HS-011 603 (Cont'd.)**

An injury criteria model and a restraint system effectiveness index for evaluating the degree to which the vehicle environment can prevent or reduce occupant injuries are described. The injury criteria model consists of three parts: an injury rating based on available human tolerance data; a relative motion criterion based on the extent to which adjacent body segments can move with respect to one another; and an index giving the probability of the crash event being studied.

Search terms: Mathematical models; Restraint system effectiveness; Accident simulation; Human body impact tolerances; Probability theory; Injury prediction; Computerized simulation; Injury prevention

examining, and evaluating the system is presented.

Search terms: Guideway systems; Public transportation; Freight transportation; Automatic highways; Systems analysis; Highway transportation; Urban transportation; Dual mode vehicles; Automatic transportation systems

**5/0 VEHICLE SAFETY****5/2 Buses, School Buses, and Multipurpose Passenger Vehicles****HS-011 605 Fld. 5/2; 1/2; 1/5****BUS COLLISION CAUSATION AND INJURY PATTERNS**

by A. W. Siegel; A. M. Nahum; D. E. Runge

California Univ., San Diego; Automobile Club of Southern Calif.

Published in HS-011 551, *Stapp Car Crash Conference (15th) Proceedings*, New York, 1972 p301-85

refs

Report no. SAE-710860

Presented at the fifteenth Stapp Car Crash Conference, Coronado, Calif., 17-19 Nov 1971.

A clinical interdisciplinary research methodology was applied to the problem of school bus and coach passenger protection. Pertinent findings of the study include collision causation factors resulting from driver, vehicle, and environmental influences. Injury causation and injury patterns are related to ejection, restraints, structure design, and seats. Occupant kinematics and the subsequent injury production are related to three classes of school bus and coach collisions. Post-collision factors influencing injury, such as egress, extrication, and fire are discussed.

Search terms: School bus accidents; Bus accidents; Occupant kinematics;

Accident rates; Fatality rates; Pedestrian injuries; Crash phase; Postcrash phase; Precrash phase; Injury causes; Injury rates; Accident case reports; Injury severity; Roof caused injuries; Rollover accidents; Interior design; Collisions; Occupant rescue; Escape from vehicle; Ejection caused injuries; Seat caused injuries; Accident caused fires; Child injuries; Accident causes; Injuries by body area; Accident types; Environmental factors

**5/4 Design****HS-011 606 Fld. 5/4****LABORATORY TESTING FOR EVALUATION OF PASSENGER CAR ROOF INTRUSION RESISTANCE STRENGTH**

by J. M. Petty

Ford Motor Co.

1972 6p

Report no. SAE-720225

Presented at Automotive Engineering Congress, Detroit, 10-14 Jan 1972.

A test facility and procedure have been developed for use in evaluating passenger car roof intrusion resistance strength in the laboratory. This facility and procedure produce reliable and repeatable data which permit numerical comparison of separate test bodies or vehicles and automatically indicate performance through the use of X,Y,Y plotter. The test facility consists of three parts: an adjustable structural frame for supporting the test unit in position for test, a hydraulic loading system for applying the load, and instrumentation for load and placement readout. A complete description of the facility is presented, with emphasis on the advantages of dual readout of data. The test procedure is also detailed, with description of sample preparation, mounting the test unit, and the graphical addition of curves.

Search terms: Roofs; Loading tests; Crush tests; Laboratory tests; Crash-

**4/8 Transportation Systems****HS-011 604 Fld. 4/8****AUTOMATED HIGHWAYS—CONFIGURATIONS**

by G. E. Wanttaja

Published in *Automotive Engineering* v80 n1 p28-37 (Jan 1972)

Based on SAE paper No. 720269 "Automated Roadway Transportation System Configurations" to be presented at 1972 Automotive Engineering Congress.

The movement of people and goods by an integrated automated roadway transportation system, the Metro Guideway, for at least part of their trip, may prove to be an important new transportation concept. New transportation facilities will be required to implement these services. Some of the transportation services, transportation facilities, and technological design choices are described. In addition, a methodology for defining,

worthy bodies; Strength (mechanics);  
Test equipment

**AVAILABILITY: SAE**

**HS-011 607 Fld. 5/4**

**BUILDING BLOCKS FOR AN ON-BOARD COMPUTER**

by T. M. Frederiksen; W. F. Davis; R. W. Russell

Motorola, Inc.

1972 8p 1ref  
Report no. SAE-720281

Presented at Automotive Engineering Congress, Detroit, 10-14 Jan 1972.

To meet the initial needs of the automotive electronic control and warning system designers, standard linear integrated-circuit building blocks are recommended. These provide both design flexibility and quick reaction to change requests. New circuit approaches to single power supply operational amplifiers, comparators, lamp and/or relay drivers, timing circuits, and voltage regulators are presented and typical performance characteristics are given.

Search terms: Integrated circuits; Analog computers; Control equipment; Comparators; Voltage regulators; Warning systems; Amplifiers

**AVAILABILITY: SAE**

**HS-011 608 Fld. 5/4; 3/4**

**HUMAN ENGINEERING APPLIED TO THE DESIGN AND GROUPING OF ELECTRICAL CONTROLS IN THE MOTOR VEHICLE**

by L. J. Nevett

Lucas (Joseph) (Electrical) Ltd.  
(England)

1972 7p 1ref  
Report no. SAE-720233

Presented at Automotive Engineering Congress, Detroit, 10-14 Jan 1972.

A study has been made of motor vehicle driver environment to determine the most desirable design features and the optimum grouping of electrical controls. Consideration is given to the psychological aspects of control operating noise level and action feel, and to styling and standardization of layout with the ultimate objective of driver fatigue reduction.

Search terms: Human factors engineering; Driver fatigue; Instrument panel design; Electric systems; Control location; Control equipment; Instrument panel lighting; Automatic warning systems; Driver vehicle interface; Attention

**HS-011 609 Fld. 5/4; 4/3**

**A FEASIBILITY ANALYSIS OF A SIMPLE CYCLE GAS TURBINE ENGINE FOR AUTOMOBILES**

by E. S. Wright; W. R. Davison; L. E. Greenwald

United Aircraft Corp.

1972 13p 18refs  
Contract EHS-70-115  
Report no. SAE-720238

Presented at Automotive Engineering Congress, Detroit, 10-14 Jan 1972.

The feasibility of a simple-cycle gas turbine engine for automobiles is analyzed by means of comparison with Otto-cycle engines for automobiles. Applicable technology is reviewed with emphasis on centrifugal compressor technology, which has demonstrated pressure ratios of better than 10:1. The design point of a simple-cycle 150 hp automobile engine based on these components is presented, together with estimated torque and fuel-flow charac-

teristics for the entire range of possible engine performance. The results of a vehicle performance computer program designed to evaluate candidates for this application include time/speed/distance performance estimates for maximum acceleration as well as fuel economy and emissions estimates for pertinent driving cycles. A speculative overall cost for both four and ten years of ownership is estimated based primarily on fuel economy and manufacturing cost derivations. It is concluded that the simple-cycle gas turbine engine studied is sufficiently attractive as a low-pollution automobile engine for the post-1975 decade to warrant full-scale demonstration as soon as possible.

Search terms: Gas turbine engines; Otto cycle engines; Feasibility studies; Computerized simulation; Exhaust emission standards; Vehicle operating costs; Automobile performance; Vehicle characteristics; Fuel economy; Automobile prices; Automobile costs; Engine design; Compressors; Engine performance

**AVAILABILITY: SAE**

**5/5 Door Systems**

**HS-011 610 Fld. 5/5; 1/2**

**DOOR CRASHWORTHINESS CRITERIA**

by J. H. McElhane; R. L. Stalnaker; V. L. Roberts; R. G. Snyder

Michigan Univ. Hwy. Safety Res. Inst.

Published in HS-011 551, *Stapp Car Crash Conference (15th) Proceedings*, New York, 1972 p489-517

36refs  
Contract FH-11-7288  
Report no. SAE-710864

Presented at the fifteenth Stapp Car Crash Conference, Coronado, Calif., 17-19 Nov 1971.

## 5/5 Door Systems (Cont'd.)

### HS-011 610 (Cont'd.)

Results of animal studies, cadaver studies, and anthropometric dummy tests have been combined to produce injury criteria for lateral impacts to the head, thorax, and abdomen. Full-scale crash simulations were performed on an impact sled to verify results of the more specialized tests and analyses. Scaling relationships for various species of animals have been developed and extrapolated to man. Significant differences in right and left side tolerances to impact were noted and detailed. Critical impact velocities for various body sites have been developed for several categories of impact.

Search terms: Side structure caused injuries; Impact velocity; Computerized simulation; Side impact tests; Animal experiments; Head injuries; Chest injuries; Abdominal injuries; Restraint systems; Bench seats; Bucket seats; Angular acceleration; Crashworthiness; Door design; Impact sleds; Impact tolerances; Accident simulation; Cadavers in testing; Anthropometric dummies; Autopsies; Primates; Secondary collisions

most important factor in determining whether or not this type of power plant can survive. Catalytic treatment of exhaust gases along with exhaust gas recycling will be necessary to meet 1975 and 1976 federal exhaust emission standards. The automotive industry has asked that lead antiknock compounds be removed from gasolines because lead fouls many catalysts and may foul re-cycle systems. However, in spite of extensive efforts, no catalyst has yet been found that has adequate activity and durability, even with unleaded gasolines.

Search terms: Unburned hydrocarbons; Carbon monoxide; Nitrogen oxides; Otto cycle engines; Exhaust emission standards; Leaded gasoline; Lead free gasoline; Exhaust gas recirculation; Catalyst poisoning; Catalyst tests; Lean fuel mixtures; Gas chromatography; Air fuel ratio

### HS-011 612 Fld. 5/6

#### SOME FACTORS AFFECTING GAS TURBINE PASSENGER CAR EMISSIONS

by C. A. Amann; W. R. Wade; M. K. Yu

General Motors Res. Labs.

1972 19p 22refs  
Report no. SAE-720237

Presented at Automotive Engineering Congress, Detroit, 10-14 Jan 1972.

The intent of this paper is to put into proper perspective the relationships among the vehicle, the thermodynamic cycle, and the combustion process as they relate to exhaust emissions from a gas turbine-powered passenger car. The influences of such factors as car size, installed power, regeneration, and other cycle variables on level-road-load fuel economy, and on the production of oxides of nitrogen and carbon monoxide, are examined. In limited checks against experimental data, the

mathematical model of the combustor has proved to be a reliable indicator of emission trends. The results of this study suggest that the high-pressure-ratio, non-regenerative cycle is not competitive on a fuel-economy basis with the traditional regenerative engine of more modest pressure ratio.

Search terms: Engine size effect on exhaust emissions; Gas turbine engines; Exhaust emissions; Vehicle size; Automobile power; Fuel economy; Nitrogen oxides; Carbon monoxide; Combustion chambers; Air fuel ratio; Mathematical models; Regeneration; Power output; Thermodynamics; Thermal factors; Combustion rate; Engine operating conditions

AVAILABILITY: SAE

### HS-011 613 Fld. 5/6

#### ACADEMY OF SCIENCES WEIGHS PROBLEMS OF MEETING '75-'76 EMISSION REQUIREMENTS

Anonymous

Published in *Automotive Engineering* v80 n3 p30-5 (Mar 1972)

The Motor Vehicle Emissions Committee of the National Academy of Sciences claims that technology to meet 1975 and 1976 standards is not yet available. However, through catalyst replacement, other maintenance and fuel controls, producers probably will meet 1975 requirements, but at higher fuel cost, plus poorer driveability.

Search terms: Exhaust emission standards; Exhaust emission tests; Hydrocarbons; Carbon monoxide; Catalytic converters; Clean Air Act of 1970; Lead time; Exhaust emission control devices; Nitrogen oxides; Evaporative emission control; Thermal reactors; Engine performance; Driveability

## 5/6 Fuel Systems

### HS-011 611 Fld. 5/6

#### MEETING FUTURE EMISSION STANDARDS WITH LEADED FUELS

by W. E. Adams; H. J. Gibson; D. A. Hirschler; J. S. Wintringham

Published in *Journal of Automotive Engineering* v2 n10 p12-16 (Nov 1971)

8ref's

The emission of unburned hydrocarbons, carbon monoxides, and oxides of nitrogen in the exhaust gases from Otto cycle gasoline engines has become the

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## VEHICLE SAFETY

HS-011 614 Fld. 5/6

### ELECTROPNEUMATIC PETROL INJECTION FOR LOW EMISSIONS

L. J. K. Setright

Published in *Journal of Automotive Engineering* v2 n10 p28-30 (Nov 1971)

A new fuel injection is described which is simple enough to create no installation problems and accurate enough to permit engine operation on very lean mixtures and to comply with emission requirements. The system gets its results by direct measurement of air flow and commonly fine atomization of the fuel spray.

Search terms: Lean fuel mixtures; Electronic fuel injection; Engine operating conditions; Fuel sprays; Air flow rates; Emission standards; Electropneumatic equipment

HS-011 615 Fld. 5/6; 5/11

### VEHICLE EMISSION CONTROL

Argano Promotions

Developed through the cooperation of the U.S. Office of Education.

A manual for service technicians who repair and maintain equipment with emission control systems is presented. The text covers the need for emission control and background information, operating principles which apply to control systems currently in use in the automotive market, and maintenance operations for the systems described. The capability of an emission control system to function effectively depends primarily on the complete combustion of fuel, which in turn depends on proper fuel-air mixtures and ignition timing. To the service technician, this means more frequent and more skillful engine tune-ups.

Search terms: Crankcase emission control; Positive crankcase ventilation; Exhaust emission control device maintenance; Air injection; Engine modification; Evaporative emission control devices; Preventive maintenance; Emission standards; Ignition systems; Instruction manuals; Tuneup; Engine performance; Ignition timing; Fuel tanks; Fuel systems; Inspection procedures; Exhaust systems

### 5/7 Glazing Materials

HS-011 616 Fld. 5/7

### LOW VELOCITY IMPACTS AND TEMPERATURE SENSITIVITY OF AUTOMOTIVE WINDSHIELDS

by R. G. Rieser; J. Chabal; C. W. Lewis

PPG Industries, Inc.

Published in HS-011 551, *Stapp Car Crash Conference (15th) Proceedings*, New York, 1972 p613-44

5refs

Report no. SAE-710869

Presented at the fifteenth Stapp Car Crash Conference, Coronado, Calif., 17-19 Nov 1971.

Headform impacts at 5.5-7.7 mph were run on glass panels that did not fracture to measure deceleration pulses and obtain severity index (SI) values. These tests show low SI values for this range of impact velocities. Dummy-windshield tests were run at speeds of 8.7-21.9 mph to measure SI and laceration. In all cases laceration is low and SI values do not indicate concussive hazard below approximately 15 mph impact velocity even when the glass does not fracture. The currently used HPR interlayer for windshields shows excellent safety performance at room temperature but is less effective at other temperatures. Impact studies of several glass structures at 30-110°F are presented for 0.030 and 0.037 in. thickness HPR interlayers.

Extensive HPR interlayer rupture occurs at 30° and 110°F producing greater laceration hazard.

Search terms: Windshield caused injuries; Laminated glass caused injuries; Glass fracture behavior; Windshield impact tests; Head impact velocity; Ambient temperatures; Injury severity index; Head forms; Impact caused lacerations; Low speed impact tests; Anthropomorphic dummies

HS-011 617 Fld. 5/7; 1/2

### INFLUENCE OF AMBIENT TEMPERATURE ON IMPACT PERFORMANCE OF HPR WINDSHIELDS

by R. L. Morrison

Ford Motor Co.

Published in HS-011 551, *Stapp Car Crash Conference (15th) Proceedings*, New York, 1972 p603-12

4refs

Report no. SAE-710868

Presented at the fifteenth Stapp Car Crash Conference, Coronado, Calif., 17-19 Nov 1971.

A population of rural vehicular accidents having a high degree of windshield contact and subsequent injury was selected. Two types of windshield impact patterns, together with their resulting frequency and severity of injury, are compared. Findings indicate that occupant injury levels are likely to be higher when the windshield interlayer is ruptured on impact, as contrasted with no rupture. The level of injury is generally reduced at ambient temperatures above 70°F, as compared with the lower temperatures.

Search terms: Glass fracture behavior; Laminated glass caused injuries;



## 5/7 Glazing Material (Cont'd.)

### HS-011 617 (Cont'd.)

Ambient temperatures; Windshield caused injuries; Head injuries; Rural accidents; Front end collisions; Injury severity

### HS-011 618 Fld. 5/7; 1/2

#### NONLACERATING GLASS WINDSHIELDS — A NEW IMPROVED APPROACH

By E. R. Plumat; R. Van Laethem; P. Baudin

Glaverbel S.A. (Belgium)

Published in HS-011 551, *Stapp Car Crash Conference (15th) Proceedings*, New York, 1972 p552-602

6refs  
Report no. SAE-710867

Presented at the fifteenth Stapp Car Crash Conference, Coronado, Calif., 17-19 Nov 1971.

Impact tests with a headform free falling on positioned samples were recorded for the deceleration peak along two orthogonal axes, the resultant severity index relating to the initial impact and to the plow-in, the tearing length of the plastic interlayer, and the laceration potential. Parameters studied were temperature, impact velocity, impact location, and increase of the mechanical strength of the sheets. The new safety reinforced laminated windshield might be used as a true passive restraint system if the tensile strengths of the reinforced glass are adjusted.

Search terms: Laminated glass caused injuries; Head forms; Head impact velocity; Impact caused lacerations; Windshield caused injuries; Windshield impact tests; Glazing materials; Injury severity index; Temperature; Angle impact tests; Glass fracture behavior; Drop tests; Test equipment

## 5/10 Lighting Systems

### HS-011 619 Fld. 5/10

#### A LOOK AT FOG LAMPS

Anonymous

Published in *Autocar* v135 n3946 p7, 9-11 (18 Nov 1971)

The types of fog lamps used in Britain and Europe are described. Shapes of the lamps and various mounting heights are discussed. Rear fog lamps are helpful in preventing rear end collisions.

Search terms: Fog lamps; Lamp mounting height; Rear lamps; Europe; Great Britain; Fog driving; Rear end collisions

## 5/14 Occupant Protection

### HS-011 620 Fld. 5/14

#### A SURVEY OF USAGE OF CHILDREN'S CAR SEATS AND RELATED DEVICES

by G. Jones

Bolt, Beranek and Newman, Inc.

1969 80p  
Report no. BBN-1829

Detailed findings of a telephone survey of mothers (from upper, middle, and lower socio-economic levels in the Boston and Los Angeles areas) regarding the use of children's car seats or other restraint devices are presented. The purpose of making the survey was to describe the ways in which children's car seats are presently used in terms of extent of use, ages at which children use them, ways children ride in cars before and after using car seats, and reasons children are changed from one device to another. It was found that babies generally ride lying down but in devices which are not adequate for protection; that children from six months to two years ride in child car seats about

50% of the time; and that older, more restless children need devices designed for them.

Search terms: Child safety seats; Child restraint systems; Questionnaires; Surveys; Infant restraint systems; Socioeconomic data; Interviews; Restraint system usage; Boston; Los Angeles; Child seat belts

### HS-011 621 Fld. 5/14

#### EFFECTS OF LAP BELT AND THREE-POINT RESTRAINTS ON PREGNANT BABOONS SUBJECTED TO DECELERATION

by A. I. King; W. M. Crosby; L. C. Stout; R. H. Eppinger

Wayne State Univ.; Oklahoma Univ.

Published in HS-011 551, *Stapp Car Crash Conference (15th) Proceedings*, New York, 1972 p68-83

7refs  
Contract FH-11-6970  
Report no. SAE-710850

Presented at the fifteenth Stapp Car Crash Conference, Coronado, Calif., 17-19 Nov 1971.

A series of 24 pregnant baboons was impacted under similar conditions. The only major variable was the difference in maternal restraint. The fetal death rate of 8.3% (1/12) among maternal animals impacted with three-point restraint was significantly different from five fetal deaths among 10 maternal animals impacted under lap belt restraint alone. It is concluded that shoulder harness restraint should be recommended for use by pregnant travelers as being significantly more protective of fetal welfare when compared with lap belt restraint alone.

Search terms: Seat belt caused injuries; Fetal injuries; Fetal death; Shoulder harness caused injuries; Seat belt loading; Deceleration caused injuries;

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## VEHICLE SAFETY

Deceleration tests; Baboons; Three point restraint systems; Pregnancy; Animal experiments; Animal deceleration tolerances

HS-011 622 Fld. 5/14

### DEPLOYABLE HEAD RESTRAINTS -- A FEASIBILITY STUDY

by J. W. Melvin; J. H. McElhaney; V. L. Roberts; H. D. Portnoy

Michigan Univ. Hwy. Safety Res. Inst.; Oakland Neurological Clinic

Published in HS-011 551, *Stapp Car Crash Conference (15th) Proceedings*, New York, 1972 p158-89

refs

Contract FH-11-7612  
Report no. SAE-710853

Presented at the fifteenth Stapp Car Crash Conference, Coronado, Calif., 17-19 Nov 1971.

Using two-dimensional computer simulations of front seat occupant kinematics in rear-end collisions, initial performance criteria for head restraint deployment times, and restraint configurations were determined for various impact velocities. Based on these criteria, two types of deployable systems were designed, one an inflatable system and the other a rigid sliding system. The test program using anthropomorphic dummies and an impact sled evaluated the effectiveness of the head restraint systems under high- and low-speed crash simulations. Results indicate that deployable head restraints are technically feasible and can provide a general level of performance better than conventional fixed head restraints.

Search terms: Head restraint design; Head restraints; Rear end collisions; Accident simulation; Front seat passengers; Computerized simulation; Impact tests; Head acceleration toler-

ances; Impact velocity; Test equipment; Inflatable structures; Occupant kinematics

HS-011 623 Fld. 5/14; 1/2

### PRELIMINARY VEHICLE TESTS -- INFLATABLE OCCUPANT RESTRAINT SYSTEMS

by J. F. Martin; D. J. Romeo

Cornell Aeronautical Lab., Inc.

Published in HS-011 551, *Stapp Car Crash Conference (15th) Proceedings*, New York, 1972 p518-51

6refs

Contract FH-11-7621  
Report no. SAE-710866

Presented at the fifteenth Stapp Car Crash Conference, Coronado, Calif., 17-19 Nov 1971.

Twelve automobiles were crashed under controlled conditions to provide head, chest, and pelvis acceleration data. Results showed head and chest accelerations were significantly lower than those that would have been received by an unrestrained occupant; femur forces and pelvis accelerations were not significantly alleviated by the presence of the air bags; double bag systems may provide more knee protection for the passenger than single bag systems. A full-width front passenger compartment installation is indicated to offer better protection than one the width of the passenger station.

Search terms: Air bag restraint systems; Head injuries; Chest injuries; Pelvic injuries; Leg injuries; Impact tests; Anthropometric dummies; Impact severity; Human deceleration tolerances; Vehicle size; Restraint system design; Test equipment; Human body size; Restraint system effectiveness

HS-011 624 Fld. 5/14; 5/4

### YOUR GUIDE TO THE FEDERAL MOTOR VEHICLE SAFETY STANDARDS

Anonymous

Published in *Popular Imported Cars* v7 n3 p4-7, 54-5 (May 1971)

The standard dealing with occupant crash protection is discussed. Passive restraint systems will be required, and the automotive industry wants more time to develop air bags or alternatives. The standard requiring stronger bumpers is also discussed and the objections of the auto industry outlined. The impact of the standards on imported cars is described.

Search terms: Vehicle safety standards; Occupant protection; Passive restraint systems; Air bag restraint systems; Bumper standards; Automotive industry; Lead time; Foreign automobiles

HS-011 625 Fld. 5/14; 5/4

### SMALLER VEHICLE VERSUS LARGER VEHICLE COLLISIONS

by D. M. Severy; H. M. Brink; D. M. Blaisdell

California Univ. ITTE

Published in HS-011 551, *Stapp Car Crash Conference (15th) Proceedings*, New York, 1972 p386-436

8refs

Report no. SAE-710861

Presented at the fifteenth Stapp Car Crash Conference, Coronado, Calif., 17-19 Nov 1971.

Mismatched sizes of vehicles were crashed in head-on, rear-end, and intersection-type tests. The safety

## 5/14 Occupant Protection (Cont'd.)

### HS-011 625 (Cont'd.)

aspects of size are shown to depend significantly on whether or not restraining devices are used by the small car motorist impacting a larger vehicle and that in some collisions, vehicle size has no bearing on injury. Certain safety advantages of a small car are inherent in its design, such as maneuverability, increased roof crush resistance, absence of power-assist steering and brake failures, all tending to make an alternative to the purchase of a large car an acceptable decision.

Search terms: Head on collisions; Side impact collisions; Rear end collisions; Intersection collisions; Vehicle vehicle impact tests; Accidents by vehicle size; Restraint system effectiveness; Injuries by seat occupation; Automobile models; Injuries by vehicle size; Compact automobile accidents; Under-ride override collisions; Test equipment; Occupant kinematics; Postcrash phase; Impact velocity

## 5/15 Propulsion Systems

### HS-011 626 Fld. 5/15

#### A LIFT FOR THE AUTO

by J. McCaull

Published in *Environment* v13 n10 p35-41 (Dec 1971)

3refs

The use of flywheels to help power hybrid cars and buses is being studied. The flywheel stores energy when spun to high speed, and vehicles using this device should be able to meet stringent emission standards. A feasibility study of flywheel propulsion is described. Engine-flywheel hybrid systems would reduce air pollution and noise and lower operating expenses. With still more development, the flywheel alone may be used to power buses and cars.

Search terms: Flywheels; Propulsion systems; Hybrid automobiles; Hybrid buses; Feasibility studies; Mechanical energy storage; Energy storage systems; Vehicle air pollution; Vehicle operating costs; Vehicle noise; Emission standards

## 5/22 Wheel Systems

### HS-011 627 Fld. 5/22

#### SAFETY EFFECTIVENESS OF STUDDED TIRES. FINAL REPORT

by K. Perchonok

Cornell Aeronautical Lab., Inc.

1971 87p 3refs  
Report no. CAL-VJ-2915-V-2

Data were collected through questionnaires and 4,511 accident reports to determine if inherent performance advantages of studded tires provided real safety benefits. The purpose of the study was to provide information aiding decisions regarding the banning of studded tires. The use of studded tires was correlated with vehicle and owner characteristics such as auto size, body style and model year, and owner age, sex, and annual mileage. The potential effects of studded tires are a reduced likelihood of being involved in an accident due to sliding; enhanced pre-impact control; and reduced accident severity.

Search terms: Studded tires; Accident rates; Snow tires; Tire chains; Accidents by vehicle size; Accidents by vehicle age; Accident report forms; Icy road conditions; Skidding accidents; Single vehicle accidents; Winter driving; Questionnaires; Vehicle control; Driver age; Driver sex; Minnesota; Accident studies; Studded tire bans; Tire performance; Tire traction; Accident reports; Tire characteristics; Loss of control

## NHTSA DOCUMENTS

### NHTSA Contractors Reports

#### HS-800 679 Fld. 1/3; 1/5

#### TRI-LEVEL ACCIDENT RESEARCH STUDY, SECOND ANNUAL REPORT. FINAL REPORT

by J. W. Garrett; R. C. Braisted; D. F. Morris

Cornell Aeronautical Lab., Inc.

1972 85p 8refs  
Contract FH-11-7098; CAL-6903-C129; CAL-7003-C129  
Report no. CAL-VJ-2893-V-2

The study conducted in an eight county area of Western New York from 1 Nov 1970 to 31 Dec 1971 was designed to obtain: exposure and accident frequency information on the driver and vehicle population; injury and vehicle damage information in current model vehicle accidents where hospital treatment was required; multi-disciplinary, in-depth investigations of injury and accident causal factors in accidents involving cars of the current or last two model years.

Search terms: Accident research; Data acquisition; Accident analysis; Compact automobile accidents; Pickup trucks; Injury statistics; Deformation; Accident studies; Head restraints; Injury severity; Trilevel accident investigation; Damage severity; Accidents by vehicle size; Multi-disciplinary teams; Accidents by vehicle age; Accident rates; Accident causes; Injury causes; Accident severity; Truck accidents

### NHTSA Imprints

#### HS-820 155 Fld. 2/8; 1/4

#### SELECTIVE TRAFFIC ENFORCEMENT PROGRAM PLANNING GUIDE

National Hwy. Traf. Safety Administration

1 66p

ective enforcement defines the traffic accident problem in terms of high frequency accident locations during selected time periods and applies enforcement against related accident-causative violations. Significant accident reductions can be expected whether this enforcement is applied by a special task force, the traffic division, or the patrol division of a police department. This program plan can be readily utilized as a management guide for the implementation of a local enforcement plan.

Search terms: Law enforcement effect on accident rates; Traffic law enforcement; Accident prevention; Systems analysis; Accident location; Accident report forms; Accident scale drawings; Traffic law violations; Police traffic services; Flow charts; Accident severity

AVAILABILITY: NHTSA

**SPECIAL ANNOUNCEMENT**

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Mr. Frank Skubel  
Information Systems Division (43-33)  
National Highway Traffic Safety  
Administration  
400 7th Street, SW., Room 5125  
Washington, D.C. 20590

Please indicate the availability source and price if there is a charge for the item.

\*U.S. GOVERNMENT PRINTING OFFICE 513-000



# executive summary

SYNOPSIS OF A RECENTLY RELEASED NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION RESEARCH REPORT

## PREVENTION OF ELECTRICAL SYSTEMS IGNITION OF AUTOMOTIVE CRASH FIRES

The purpose of this study was to examine ignition sources of automotive crash fires as an aid in the development of performance criteria for crashworthy automotive electrical systems to be incorporated into a proposed motor vehicle safety standard.

Contract FH-11-7347  
Dynamic Science  
1800 West Deer Valley Drive  
Phoenix, Arizona 85027

Award Amount: \$32,630.00  
Period of Contractual Performance  
June 27, 1969 through March 27, 1970

DOT/HS-800 392

### General Comments

The occurrence of fire in automobile accidents, although virtually insignificant from a statistical viewpoint, results in a totally disproportionate number of deaths and injuries to the occupants involved. Available data indicate that fires result in a fatality rate approximately seven times that of all other automobile accidents yet fire occurs in only about 0.5 percent of all passenger automobile accidents.

If a fire is to occur, two basic components are required: (1) an ignitable fuel/air mixture and (2) an ignition source. In automotive crash fires the primary fuel source is gasoline from ruptured fuel tanks and/or lines. The ignition source may be either electrical sparks from damaged electrical components or friction sparks created by contact of the vehicle with the roadway or some obstruction. While it may be technically feasible to partially or completely control the fuel and ignition sources, design criteria for each is necessary.

As part of a continuing effort by the U.S. Department of Transportation, National Highway Traffic Safety

Administration to reduce the deaths and injuries resulting from automotive accidents, a contract was awarded Dynamic Science, A Division of Marshall Industries. The contract called for the accomplishment of three tasks as follows.

Task 1 - Acquisition of Automotive Electrical System Pre and Postcrash Data

Task 2 - Evaluation of Potential Methods for Pacification of Automotive Electrical Systems

Task 3 - Preparation of Design Guide for Future Automotive Electrical Systems

### Procedure and Methodology

To accomplish these tasks, Dynamic Science proceeded in this way:

Sixty-six 1967 through 1970 model automobiles were examined on dealer lots during the Task I effort to obtain data on electrical and fuel system component

locations. The data were then compiled and a diagram prepared showing typical component locations for each of the following general classifications of automobiles:

- Front engine passenger cars
- Front engine station wagons
- Rear engine passenger cars
- Light vans
- Pickup trucks

Numerous automobiles representative of these same classifications were also examined in local wrecking yards to determine the amount and type of component damage resulting from typical accidents.

Using the data gathered from the automobile examinations along with individual estimates of probable fuel spillage, the probability of ignition due to damaged electrical system components was evaluated for various types of accidents.

In Task 2, potential methods of pacifying the electrical system were examined. Methods considered included shielding, component relocation, use of impact sensing devices to inert the electrical system, and combinations of these methods.

In Task 3, the results of the previous two tasks were combined to formulate suggested design criteria to reduce the probability of postcrash fire ignition due to electrical system failure. These design criteria are presented in the form of a design guide.

Performance criteria for crashworthy automotive electrical systems were then formulated and incorporated into a proposed motor vehicle safety standard.

## MAJOR FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

Based on the results of the study, the following conclusions are drawn:

- Although postcrash fires occur in less than one percent of all injury-producing accidents involving passenger cars, the fatality rate in automotive postcrash fires is over seven times the fatality rate in accidents where fire did not occur.

- Although data relating to the cause of automotive postcrash fires is very limited, it appears that the two most likely sources of ignition are sparks from damaged electrical systems and friction sparks created by impact.
- From a postcrash fire ignition viewpoint, the most hazardous components in the automotive electrical system are the high capacity components such as the battery, voltage regulator, alternator/generator, starter solenoid, and the wiring associated with these components. These components and their wiring are often located near the exterior of the vehicle where they are vulnerable to damage.
- Any electrical component or wiring located near the exterior of the vehicle may be considered a potential source of fire ignition.
- The battery is a particularly hazardous component from the fire ignition standpoint for two reasons. First, the battery is capable of producing a spark even when disconnected from the electrical system and/or partially destroyed. Second, the battery is often located near the exterior of the vehicle where it is vulnerable to damage.
- The postcrash fire ignition potential of present automotive electrical systems can be substantially reduced through a combination of the following methods:
  - Relocating electrical components and wiring as far as possible from the exterior of the vehicle.
  - Shielding components and wiring in non-conductive, impact-resistant containers to protect them from damage.
  - Providing an impact-sensitive device which will inert the electrical system in a severe impact or roll-over.
  - Further study and testing is needed to more accurately define the minimum acceleration environment necessary to insure actuation of an electrical system inerting device while precluding inadvertent actuation under normal operation.
  - A safety standard is needed to set forth minimum requirements for the perform-

ance of automotive electrical systems to reduce the fire ignition potential of these systems.

- Testing should be conducted to reinforce the requirements set forth in the above mentioned standard.

## Recommendations for Future Study

Since one of the prime fire ignition sources is the automobile electrical system, it is the opinion of the contractor that this system must be rendered incapable of functioning as an ignition source during or immediately after crash impact. Two of the key steps necessary to accomplish this are: (1) protection of hazardous electrical system components and (2) inclusion of a crash-sensitive inerting device in the electrical system. The following recommendations are considered necessary to the development of these safeguards against electrical system ignition of post-crash fires.

1. Commercially available inerting devices should be tested on an impact sled to determine their operational characteristics and limitations.
2. The probability of inadvertent actuation of inerting devices should be determined by conducting a series of controlled road tests involving severe operating conditions.
3. Non-conductive, impact-resistant housings should be developed which will successfully contain and protect electrical system components in the crash environment.
4. A series of full-scale automobile crash tests should be conducted to determine the effectiveness of protecting and inerting the electrical system during crash situations. These tests could be readily "piggy backed" on crash tests conducted for other studies.
5. The results of the preceding tests should be used to further reinforce the proposed standard for crashworthy automobile electrical systems.
6. A thorough analysis and test of crashworthy fuel systems should be conducted in parallel with the crashworthy electrical system program to minimize the postcrash fire hazard. Special emphasis should be made to evaluate the crashworthy performance of evaporative emission control devices during this fuel system evaluation.

7. From an economics viewpoint, it would be desirable to conduct a cost-effectiveness study to determine the costs associated with implementing a crashworthy electrical system in future vehicles.

The above recommendations present a comprehensive approach to the development of crashworthy automobile electrical systems. The first two recommendations will accumulate necessary, but presently unavailable, data on the inertia switches currently manufactured for use in automobiles. The third recommendation will generate a new and critical method of shielding the electrical system components. The program will culminate in full-scale crash tests of complete crashworthy electrical systems. The results of this program will furnish a sound data base for a crashworthy automobile electrical system standard. It should be noted that although the emphasis is placed on the electrical system in these recommendations, further work is required to provide a crashworthy fuel system and thus eliminate postcrash fuel spillage.

Two separate testing programs are necessary to evaluate the inertia switches. One program would obtain the operational characteristics of the devices. Information on actuating G levels, actuation times, and sensitivity to various impact directions would be obtained from tests conducted on a high-speed sled.

The second testing program would obtain data on the inadvertent actuation of the sensing switches. Controlled road tests would be conducted during which the test vehicles containing the switches are driven at varying speeds under severe operating conditions. These conditions should include panic stops from high speeds, rapid accelerations, and driving over railroad tracks, bumpy roads, curbs, and dips. Instrumenting the test vehicles to record operating accelerations would allow the precise determination of the minimum G level desirable for actuating the switches.

The development of crash-resistant component housings could be initiated concurrently with the inertia switch testing. After suitable material and design criteria are established, prototype containers would be fabricated for testing.

A limited series of full-scale automobile crash tests would be necessary to fully evaluate the effectiveness of a crashworthy electrical system. The automobiles would not only contain the inertia switches and protective component housings discussed above, but would also incorporate additional crashworthy measures, such as relocated components and extra length electrical wires. Front, rear, and side-impact

crashes, as well as roll-overs would be conducted under controlled conditions with automobiles which have been fully instrumented to record the acceleration levels experienced during the crash. A side benefit of such a series of tests would be the generation of additional crash impact acceleration data which could be used in the design of other crashworthy features and components. In fact, the full-scale tests proposed here could be "piggy backed" on other crash tests conducted by the National Highway Traffic Safety Administration. A natural program would be to superimpose this test program on one associated with the design and development of a crashworthy fuel system.

The results of the preceding tests would be used to reinforce the suggested design criteria presented in the report.

A recommended cost analysis is thought necessary to establish a baseline for determining the ultimate expense to the automotive buyer to provide this safety feature.

The Contract Manager has certified that the contractor's work has been satisfactorily completed and that all contractual obligations have been met.

The opinions, findings, and conclusions expressed in this summary are those of the contractor and not necessarily those of the National Highway Traffic Safety Administration.

Availability: NTIS, order DOT/HS-800 392 in paper copy (PC) or on microfiche (MF).





# executive summary

A SYNOPSIS OF A RECENTLY RELEASED NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION RESEARCH REPORT

## DESIGN OF FIELD AND CRASH TEST PROGRAMS FOR INFLATABLE OCCUPANT RESTRAINT SYSTEMS. FINAL REPORT

This report presents the results of research to design a test program for inflatable occupant restraint systems (IORS). The purpose of the test program is to evaluate the long-term effectiveness, reliability and maintainability of IORS by carrying out a series of crash tests and field tests.

Contract No: FH-11-7529  
Battelle Memorial Institute  
505 King Avenue  
Columbus, Ohio 43201

Award Amount: \$49,150.00  
Contractual Period:  
June 12, 1970 through November 12, 1970  
Report Date: November 1970

DOT/HS-800 395 Final Report

### GENERAL COMMENTS

For purposes of this study IORS effectiveness was taken to mean the expected reduction of fatalities and serious injuries which can be directly attributed to IORS performance in the real-world accident environment, if implemented in the national vehicle population. IORS performance was taken to be the accident-survivability potential provided by the IORS.

In this study it was assumed that the primary differences among IORS systems are in the bag configuration, i.e., single bag or double bags (which include knee bags); performances due to differences in inflator and sensor types, and differences in the same basic systems from different supplies was assumed to be insignificant.

### RESULTS

In accordance with the National Highway Traffic Safety Administration objectives, detailed plans were

developed for performing the following crash tests these projects:

#### Preliminary projects

- 12 vehicles, *forward* impact protection with retrofit installations for front seating *positions*
- 12 vehicles, multidirectional impact protection with retrofit installations for *all* seating *positions*

#### Expanded Projects

- 60 vehicles, forward position
- 100 vehicles, all positions

According to the contractor, results from the proposed crash tests could be expected to yield data useful for

Evaluating the accident-survivability potential of a wide range of impact types, impact velocities, occupant combinations, vehicle types, and IORS configurations.

These data would be in the form of accelerations and forces as measured on anthropometric dummies. IORS performance can then be evaluated by interpreting these data in terms of injury severity.

Generating an IORS performance envelope through interpolation and extrapolation among specific test conditions, and estimate IORS effectiveness by comparing this with a similar envelope obtained without IORS's (i.e., based on current real world accident results).

Proposed field tests would include:

Pilot tests

750 vehicles with retrofit installations for forward positions

750 vehicles, with retrofit installations for all positions

Full-scale test

12,500 vehicles, factory installed IORS

Results from the field test program could be expected to:

Yield data for the direct estimate of IORS effectiveness by comparison of results between a test fleet and a control fleet. However, the data would arise from small samples and the fleet could well be biased (e.g., all full-sized cars). Therefore, statistical and engineering interpretation of the results must be made.

Provide a basis for determining the size of a suitable field test program; establishing the budgetary, technical and management resources necessary to support the test program; and structuring the nature of the analyses and evaluation of IORS performance.

The Contract Technical Manager has certified that the contractor's work has been satisfactorily completed and that all contractual obligations have been met.

The opinions, findings, and conclusions expressed in this summary are those of the contractor and not necessarily those of the National Highway Traffic Safety Administration.

Availability: National Technical Information Service (NTIS), Springfield, Va. 22152. Order in paper copy (PC) or microfiche (MF), DOT/HS-800 395.



# executive summary

## A SYNOPSIS OF A RECENTLY RELEASED NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION RESEARCH REPORT

### METHODOLOGICAL CONSIDERATIONS IN CONDUCTING AND EVALUATING ROADSIDE RESEARCH SURVEYS. FINAL REPORT.

The purpose of this project was to present some methodological considerations in the conduct and evaluation of roadside research surveys and to develop guidelines that could be used in the planning and performance of future surveys.

Contract No. FH-11-7543  
Department of Psychology  
John Dewey Hall  
University of Vermont  
Burlington, Vermont 05401  
DOT/HS-800 471 Final Report

Up to this point in time the ASAP Program  
total funding through Feb. 2, 1971: \$370,651.00\*

Contractual Period:  
June 25, 1970  
through June 30, 1974  
Report Date: February 1971

(This is a continuing study through 1974)

#### GENERAL COMMENTS

Roadside research surveys are needed to provide information which can be used in working toward an eventual solution to the problem of losses which result from highway crashes: human losses, property losses, economic losses, time losses, etc.; the most compelling loss being serious or fatal injury to human beings.

Alcohol is now recognized as being an important component in approximately half of the fatal injury crashes, and societal agencies have focused specifically upon alcohol involvement in highway crashes in an attempt to achieve solutions for some portions of the basic problem. Thus, public interest and governmental pressure are providing a mandate and a social imperative to study this problem and to use whatever methods are necessary in terms of achieving the greater good for the greater number despite possible inconvenience for the citizens involved. The roadside research survey is one of the most promising and most highly regarded, yet least used methods available for

studying selected aspects of this problem.

#### RATIONALE OF ROADSIDE RESEARCH SURVEYS

In the opinion of the contractor roadside surveys are the only effective investigative means appropriate and feasible to collect the necessary data. The following paragraphs present a discussion of the rationale.

The basic problem comprises individuals who personally come to the attention of medical and/or enforcement agencies as a result of involvement in a fatal or serious injury crash. Since these cases are tangible and identified, it is relatively simple to obtain extensive demographic and biographical data concerning these individuals involved. However, no amount of extensive detailing of their individual data provides any reliable insight into the characteristics and composition of the population from which they were sampled. Until the prevalence of a particular parameter has been determined (for example, a characteristic such as a blood alcohol concentration) in the population from which the individual is sampled

*\*This particular study cost \$10,000.00 out of  
the total funding*

(the so-called "population-at-risk"), there is no logical or practical way of evaluating the contribution of this particular parameter to the core problem (i.e., alcohol-involved highway crashes). In other words, one approach to understanding and solving the core problem is through identifying those aspects which co-exist or are at equal exposure but which are not an immediate part of the manifest problem, that is, do not become involved in highway crashes. This approach is based upon understanding the normal or adaptive segments of the population in order to gain perspective and insight into the causes for the maladaptive segments of the same population, namely, those who get into trouble on the highway. Unless corresponding data from the properly functioning segment of the population are obtained for comparison purposes, even the most intensified study of persons from the improperly functioning segment would not very likely provide an understanding of the reasons for their failure, that is, for their having become part of the core problem.

Therefore the contractor feels it is necessary to select a sample plan for each set of roadside interviews that will facilitate the collection of the data which are appropriate to the investigation being undertaken. These plans might be based on: (1) hourly traffic densities, (2) times and places of fatal alcohol involved crashes, (3) times and places of serious injury alcohol involved crashes, (4) times and places of all fatal crashes, (5) times and places of all serious injury crashes, (6) police enforcement patterns, (7) randomization.

Furthermore, even though a particular motorist happens to be selected on a pre-arranged random basis and accordingly stopped at a specified point in space-time for the survey, there is no effective means of obtaining the desired information short of actually asking the motorist. Therefore, it is especially important that he be convincingly informed of this need of the scientists and evaluators in order to encourage him to place it high enough in his own hierarchy of needs so that he will in fact cooperate and provide the requested information at the moment.

## FUNCTIONAL CONSIDERATIONS OF ROADSIDE SURVEYS

The two primary functions of the surveys are: (1) to provide data for describing the basic problem in terms of identification and specification of assumedly relevant parameters, and (2) to provide data for evaluating the results of any changes in circumstances surrounding the basic problem, whether they are the result of unplanned natural events, on the one hand,

or controlled premeditated countermeasures, on the other.

For the first function, it is necessary to obtain data to describe the core problem as accurately as possible in terms of those parameters which are assumed in advance to be of relevance for both the prevalence and the incidence of the problem (in this case, serious injury highway crashes involving alcohol). Although the roadside survey provides a significant supplement to data from public records, it also represents a means of obtaining certain types of data which probably cannot be duplicated or achieved in any other manner.

Regarding the second function there are at least three time periods during which data are necessary in order to achieve a proper basis for adequate evaluation: before, during, and after the countermeasure program. Roadside surveys cannot provide direct measures of the problem itself which consists of fatal and serious injury crashes involving alcohol.

One of the primary functions of roadside research surveys is to obtain alcohol information which is assumedly related to the incidence of the basic problem. Thus, no inferences about the impact of the countermeasures can be made unless baseline measures were obtained on the specified parameters prior to starting the countermeasure program since the very implementation of the program is likely to contaminate and/or confound the situation being studied, to such an extent that subsequent separation and analysis of the confounded variables is impossible. These baseline data are of crucial immediate importance to the scientist-evaluator, but they are very likely to be minimized or denigrated by inadequately informed administrators, police officials, and even the citizen motorist (if he is involved prior to the public announcement of the actual program). However, the importance of the baseline data absolutely cannot be overemphasized if subsequent developments in the program are to be meaningfully evaluated.

The second time period for the use of roadside surveys in evaluation consists of the actual implementation phase of the countermeasure program, during which time it may seem relatively more important for the program administrator than for the scientist to obtain relevant intermediate measures on the basis of which to track the assumed impact of the countermeasures and to catch a provisional preview of emergent trends. Furthermore, if the countermeasure program is focused on the problem of alcohol and highway safety, a subtle additional consideration during this implementation phase concerns evaluation of the

influence of the evaluation method itself, namely, the potential influence or intrusion of the roadside research surveys on the very subject which is being studied: driving after drinking. The very knowledge that such surveys are being conducted may well influence the motorists in the area to modify their driving behavior vis-a-vis alcohol. However, there is probably no effective means of either evaluating or obviating this probable intrusion. Suffice it to say that if the intrusive impact of the roadside surveys is sufficient to reduce driving after drinking, then the surveys themselves should be considered as a potential countermeasure.

The last and most obvious time period for use of roadside surveys in evaluation comes at some point after termination of the countermeasure program. It is important at the end of any program to ask whether or not it has been effective; however, a more subtle and frequently unasked question concerns the persistence of the assumed effects over an extended period of time following termination of the program itself. The scientist is more likely to be interested in obtaining post-program data-points for a longer period of time than is the program administrator who is more likely to be pressed by other problems, including limited funds.

Finally, potential use of the survey occasion for public education purposes should not be overlooked. Presumably the citizen-motorist will be more attuned to statements from the roadside research survey personnel and police officers than he would to the same messages presented passively in the mass media. Roadside personnel can impress upon the motorists the magnitude of the problem of severe crashes involving alcohol, as well as the fact that (1) research is conducted only in those areas which the public feels to be important, and (2) the research program can be no more effective than the support which the public gives it. The interviewer should be able to leave the motorists with the feeling that the responsible public had demanded that he be out there investigating the problem and that, by his very being there, he is able to provide the motorists with the opportunity to cooperate with a program effort which the public themselves had in fact originally instigated and created.

In the report the contractor provides detailed suggestions for the following:

- Preliminary survey planning
- Selection and training of survey personnel

- Survey scheduling
- Interview procedures including suggestions for handling the alcohol-impaired driver
- Interview termination procedures
- Criteria for data security, privacy, and quality control

The Contract Technical Manager has certified that the contractor's work has been satisfactorily completed and that all contractual obligations have been met.

The opinions, findings, and conclusions expressed in this summary are those of the contractor and not necessarily those of the National Highway Traffic Safety Administration.

Availability: National Technical Information Service (NTIS), Springfield, Va. 22152. Order in paper copy (PC) or microfiche (MF). DOT/HS-800-471.



# executive summary

SYNOPSIS OF A RECENTLY RELEASED NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION RESEARCH REPORT

## DEVELOPMENT OF HIGHWAY SAFETY STATISTICAL INDICATORS. FINAL REPORT

The overall purpose of this study was to develop a set of statistical indicators that could be used to evaluate the National Highway Safety situation so that sources of safety problems and potential means of alleviation could both be identified.

Contract No. FH-11-7505  
Operations Research, Incorporated  
1400 Spring Street  
Silver Spring, Maryland 20910  
DOT/HIS-800 472 Final Report

Award Amount: \$58,687.00  
Contractual Period:  
May 28, 1970 through May 28, 1971  
Report Date: March 1971

### GENERAL COMMENTS

As part of the overall study objective, effort was devoted to developing statistical indices to measure the economic loss associated with vehicle crashes. These indices include measures of crash and injury number and severity, significant trends influencing highway crashes, and a measure of changing exposure (vehicle-miles traveled) at both the statewide and subgroup (exposure class) levels.

### RESULTS

The end product of the study was a set of indicators applied to existing data upon accident records currently used by all states. The indicators integrate all significant features of the "highway crash situation" in order to measure accident trends. Further, they provide a common base for measuring all physical damage elements associated with crashes. The following specific end products were the outgrowth of the tasks completed during the study:

- An economic loss model relating the physical

damage from crashes to the resultant monetary costs incurred by the victims

- A set of exposure classes based upon a stratification of significant trends influencing the highway crashes and the resultant economic loss
- A value index for measuring the level and the change in the economic loss from a specified base period
- A real cost index, adjusted for price change and vehicle-miles traveled, to measure the real cost of highway crashes and injuries (mortality, morbidity, and property damage—MMPD) in terms of economic loss.

Estimates were derived for these measures and the economic loss model was implemented in a test run that employed "real" data derived from crash records for the State of Wisconsin for the years 1964-1967.

## RECOMMENDATIONS FOR FURTHER REFINEMENT OF INDICES

This study represents an initial effort in a very complex area that is currently characterized by limited theoretical and practical application. Additional efforts will be required to make the set of highway safety statistical indices completely "operational." According to the contractor, the indices developed as a result of this study permit NHSTA to view highway safety in a comprehensive, consistent manner and to identify significant trends.

Recommendations outlined in the report improve the performance of the index formulations and at the same time to further test their applicability to the highway crash situation are as follows:

### o Continuing Analytic Studies to Improve Index Performance

At this stage, continuing studies should be directed toward further in-depth analysis of the current index formulation and possible extensions and improvements. Several alternatives for additional research are:

- Extend the index analysis for the State of Wisconsin to 1970 to permit further assessment of the performance of the statewide index and the exposure class indices derived through the stratification of crashes. The investigation of the exposure class indices is required, especially in view of the observed excessive fluctuation. Further analysis will be concerned with enlarging the sample size and revising the stratification of crashes, to ameliorate the sharp index fluctuation.
- Perform further sensitivity analysis of the magnitude and variability of economic loss, especially that associated with the fatalities. Investigate refinements in the index computation, specifically with respect to estimating the economic loss associated with fatalities versus other injuries by type.
- Further investigate the index formulation, using an additional state with different driving conditions, to test the feasibility of the current stratification, to make comparisons with the Wisconsin test case, and to examine alternative weighting schemes for comparing the crash situations in different states.
- Develop an improved set of exposure classes, using not only the observed accident and injury data, but also the vehicle-miles traveled data for selected driver groups as developed in a recent

University of Michigan survey.

### o Improve and Extend Analysis for Development of a National Index.

- Investigate the geographic variation in economic costs associated with crashes and the resulting MMPD. To develop a national index of economic loss, the extent of the geographic variation in economic costs must be investigated so that a factor can be accounted for properly in the sample of insurance claims.
- Investigate the stability of the index weights over time, so that the index continues to reflect the highway accident situation. Since the index weights are derived for a specific year, it is important to verify that they remain stable.
- Investigate the capability of current state accident files to provide the required data elements for the index of economic loss. A survey of the states to determine overall data availability and expected problem areas is definitely required in developing a national index of the highway crash situation.

### o Improve Index Capability

- Develop a more detailed crash injury classification design. To relate the injury severity to crash severity, the injury classification must be sensitive to the variation in type and degree of injury. For the index to be responsive to these subtle trends, the scheme used to classify crash victims by type of injury must reflect the distribution of physical damage.
- Develop a scale for vehicle damage, similar to the injury scale, which will allow the introduction into the index of refined property damage loss estimates that directly reflect the distribution of vehicle damage. Such an index of vehicle damage could then be compared directly to injury severity crash outcomes to produce an additional, noneconomic, measure of the two variables.

The Contract Technical Manager has certified that the contractor's work has been satisfactorily completed and that all contractual obligations have been met.

The opinions, findings, and conclusions expressed in this summary are those of the contractor and not necessarily those of the National Highway Traffic Safety Administration.

Availability: National Technical Information Service (NTIS). Springfield, Va. 22152. Order in (PC) microfiche (MT). DOT HS-800-472

# U.S. DEPARTMENT OF TRANSPORTATION

## NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

Research Institute, Office of Accident Investigation and Data Analysis

WASHINGTON, D.C. 20590

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